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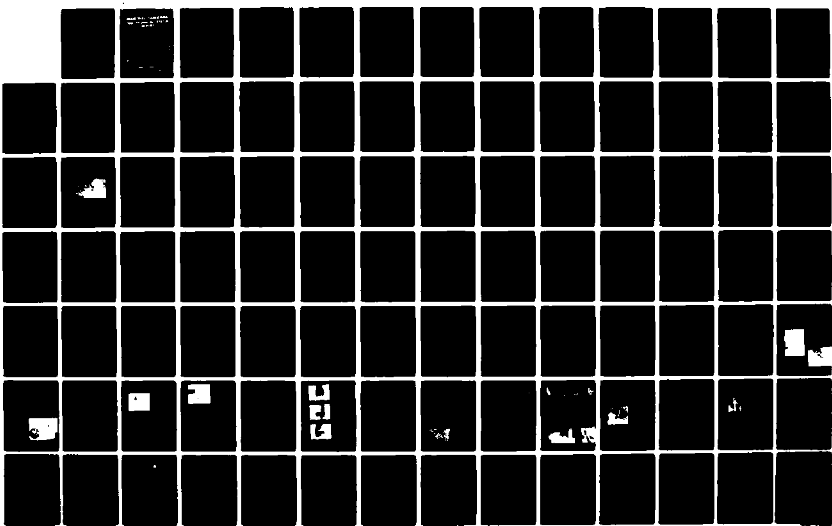

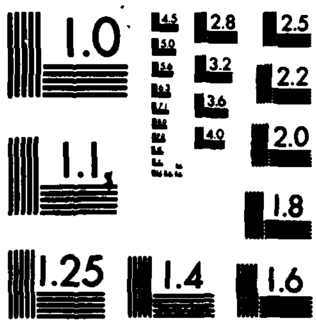
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INDUSTRIAL HARDENING 1982 TECHNICAL STATUS REPORT

FINAL REPORT

for

FEDERAL EMERGENCY MANAGEMENT AGENCY
WASHINGTON, D.C. 20472

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Contract No. EMW-C-0701
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This report presents the results of the second year of a five-year program to improve and augment a self-help program in disaster preparedness for industry Under this program, industrial protection guidelines have been developed to enable U.S. industry to reduce its vulnerability.

Follow-on work addressed the vulnerability to the complete gamut of emergencies — from day-to-day emergencies (industry's main concern) to nuclear attack — as a strategy to induce industry to adopt an integrated all-hazards

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preparedness program. Most important has been the problem of how to influence industry to apply the countermeasures developed; the specific method applied has been strong contractor participation in a local mutual aid group consisting of industrial and governmental agencies concerned with developing more effective response to community emergencies. This approach has been extremely successful in improving information exchange and in developing preparedness concepts that fit the FEMA strategy of an integrated emergency management system approach. The report summarizes the present status of these efforts.

(DETACHABLE SUMMARY)

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by

J.V. Zaccor, G.W. Smith, and R.D. Bernard

for

Federal Emergency Management Agency
Washington, D.C. 20472

Contract No. EMW-C-0701, Work Unit 1124D

FEMA REVIEW NOTICE:

This report has been reviewed in the Federal Emergency Management Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Federal Emergency Management Agency.

Scientific Service, Inc.
517 East Bayshore, Redwood City, CA 94063

(DETACHABLE SUMMARY)

INDUSTRIAL HARDENING: 1982 TECHNICAL STATUS-REPORT

This report presents the results of the second year of a five-year program to improve and augment a self-help program in disaster preparedness for industry. Under the program, industrial protection guidelines have been developed to enable U.S. industry to reduce its vulnerability to disaster, whatever the causes. The objective of the guideline is to provide industry with practical options that can be applied in advance, or on short notice where there is warning time.

Under earlier programs, the guideline was oriented specifically toward countering a nuclear attack, but then revised to make it more general, and subsequently followed up with tests and demonstrations that were conducted to show technical and practical feasibility. Follow-on work addressed the problem of developing information and options that would reduce industrial vulnerability to the complete gamut of emergencies — from day-to-day emergencies (industry's main concern) to nuclear attack — as a strategy to induce industry to adopt an integrated all-hazards preparedness program. Most important has been the problem of how to influence industry to apply the countermeasures developed, something extremely difficult to accomplish with monologues alone. Dialogue has been found to be the most effective way to develop rapport and credibility with industry, and the specific method applied has been strong contractor participation in a local mutual aid group consisting of industrial and governmental agencies concerned with developing more effective response to community emergencies. This approach has been extremely successful in improving information exchange and in developing preparedness concepts that fit the FEMA strategy of an integrated emergency management system approach. The report summarizes the present status of these efforts.

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Section 1
INTRODUCTION

This report summarizes studies conducted for the Federal Emergency Management Agency (FEMA) by Scientific Service, Inc. (SSI), in the period June 1982 through January 1983, on a continuing effort to improve and augment a self-help disaster preparedness program for industry. As part of the program, a manual was developed to provide industry with practical procedures to reduce vulnerability to nuclear attack; subsequently, preparedness for natural disasters was integrated into it to provide more impetus for industry acceptance and application.

The original work commenced with the development of a working draft of the manual (Ref. 1), which was demonstrated and tested with industry involvement the following year (Ref. 2). The manual was then revised to incorporate these results, and further analytical and experimental work was initiated to develop additional techniques to protect (harden) equipment and to provide better estimates of equipment vulnerabilities. This first iteration of revisions was tested, and potential inducements to stimulate industry planning and preparedness for emergencies were considered (Ref. 3). In the next iteration, new analytical and experimental input was developed to provide more comprehensive coverage of disaster preparedness, and program elements were established to expand the sphere of interested industries (Ref. 4).

In the most recent study, conducted under Contract No. EMW-C-0701, work has been continued to: extend the analytical and experimental base for the manual; integrate into it preparation for everday exigencies and natural disasters, which will augment preparedness for nuclear disaster; establish additional contacts with industry to foster development of emergency preparedness, in general, and nuclear disaster preparedness in particular; and foster government/industry rapport through SSI supportive effort to interested industries. The work in this period has been undertaken through seven tasks, some of which relate to the manual and its

evolution, and others to the enhancement of industry goodwill and response to the program and to information exchange among the contractor, FEMA, and industry. These tasks are described, briefly, below and in more detail through the body of the report, as indicated.

(1) Develop practical information for industry use on: (a) Utilities alternatives, (b) Toxic materials management, (c) Shutdown guidance. (Sections 3, 4, and 5, respectively.)

(2) Develop data on (i.e., inventory) industrial equipment found in critical industries, specifically with regard to common production elements. (Section 6)

(3) Develop data on (i.e., inventory) common production elements found in non-critical industries. (Section 7)

(4) Expand rapport with industry to: (a) Increase the incidence of emergency preparedness, (b) Broaden the type of emergency preparedness, (c) Provide industry with practical information to apply to emergency preparedness. (Section 8)

(5) Develop pictorial material for use in promoting emergency preparedness and to provide basic information for industries that wish to take action. (Section 9)

(6) Develop simplified vulnerability assessment and hardening decision procedures. (Section 10)

(7) Initiate a procedure for identifying stockpile requirements. (Section 11)

The following section, Section 2, provides background information to provide a frame of reference for the program; general conclusions and recommendations appear in Section 12.

Section 2
BACKGROUND

The objective of the manual, to which this work applies, is to guide users in identifying and organizing activities that employ, upon instructions to relocate, plant personnel and resources to accomplish the related tasks of protecting production equipment — and employees and their dependents — in a disaster emergency. The objective is to increase significantly the post-disaster survival of people and local production resources required to maintain them. The approach is two-part and requires preplanning. It involves moving everyone — and everything critical and particularly susceptible — away from vulnerable areas to outlying regions where they can be dispersed and protected more simply, and it involves protecting key production resources that are left in the impacted region. In lieu of a program to provide disaster shelters for the population at large at two key locations, at home and at work (as has been done in Sweden), and/or to foster greater permanent dispersion of human and industrial resources, this option offers promise of having a significant positive impact on survival of the general public in the event of a national emergency.

The procedure whereby people move out of an incipient (or an established) disaster area and disperse into lower risk areas is as old as mankind and quite common today in the hurricane zone of the gulf coast. In FEMA parlance it is termed Crisis Relocation, and it is logical to expect the process will be more efficient if planned and organized in advance of a disaster than if it is left to chance; i.e., to occur sporadically (if at all). Moreover, in an industrial society, loss of a significant portion of industry will be a disaster unto itself. Consequently, it is important to post-disaster survival of the populace that steps also be taken to ensure that industry survives. The procedure whereby industrial vulnerability is reduced has been termed "hardening". Development of methods to achieve and to constantly improve upon this hardening is the main objective of the continuing effort of this program.

Industrial hardening encompasses virtually any method to protect industrial resources (both personnel and equipment) against: damage from ground motions and building collapse; crushing, overturning, and impact; hurricane winds, and flying missiles and debris; fires; and, when possible, consideration of the electromagnetic pulse (EMP) phenomenon associated with nuclear weapons. Equipment protection methods include:

(1) Evacuating equipment — particularly vulnerable or critical control and subassemblies — out of the pending disaster area
(2) Shielding remaining equipment against building collapse, missiles, flying debris
(3) Using expedient measures to strengthen underground facilities so they are less likely to collapse
(4) Preventing equipment from sliding and/or overturning under hurricane-like wind forces
(5) Removing combustibles and eliminating ignition sources
(6) Disconnecting long conductors, such as antennas and power cables, from electronic and electrical equipment (and possibly installing EMP protection on communication equipment)

Methods, required resources, and alternatives for hardening have been compiled into an integrated collection of booklets, each of which is designed to be self-contained (including instructions, worksheets, and examples) and to be compatible with Crisis Relocation. The booklet arrangement also facilitates updating, expansion, and revision as new findings, policy changes, etc., may warrant periodically. Figure 1 identifies the ten booklets, and their relationship, in a flow diagram.

The manual is arranged so that each of the booklets can be assigned to a coordinator to plan and supervise the completion of each of the activities (concurrently, if necessary). The booklets are designed for immediate application to guide the user towards a more efficient appraisal of resources and methods to protect equipment, using locally available options. (It is anticipated that later versions will principally augment, rather than change, information and procedures

CRISIS RELOCATION INDUSTRIAL HARDENING PLAN

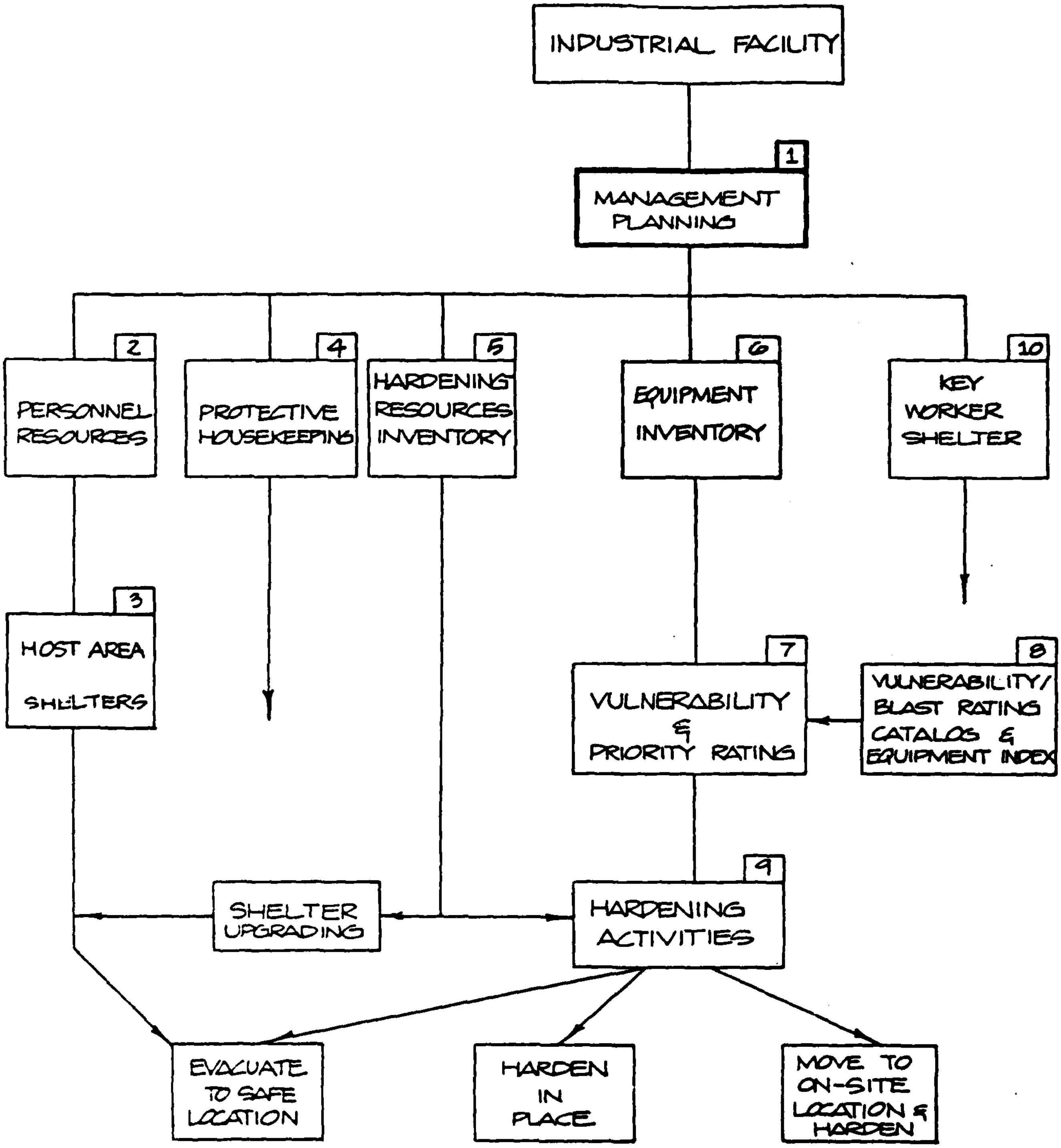


Fig. 1. Crisis Relocation Industrial Hardening Plan.

provided.) There are two phases to the process: the planning phase, which is best completed well in advance of any disaster; and the execution phase, which can be carried out in a short time period on warning of an impending disaster. Priorities for hardening attention are established in the planning stage, systematically, by plant personnel, applying in-house perceptions of the relative importance of equipment to company production objectives. In the execution phase, resources are allocated according to the earlier ranking, and the hardening activities carried out.

For an industrial preparedness program to be effective, it is necessary to provide business and industry with simple, thoroughly **tested** techniques and procedures commensurate with plant personnel and company economic capabilities. This **testing** must evaluate not only how effective the techniques and procedures are in reducing damage (when properly implemented) but whether diverse industrial implementers can apply the techniques and procedures reasonably and effectively, and with what variation. These are factors in establishing the **technical credibility** of a program to protect industrial capability (PIC). Effort in this direction provides **necessary** but **not sufficient** conditions for industry to give PIC some serious consideration; there are additional factors that must be considered before there will be much industry response.

To be truly effective, it is **absolutely necessary** to identify the conditions that will make industry take this subject seriously. It should go without saying this will not happen spontaneously, but will, in fact, require input from industry, which requires the establishment of rapport and **dialogue**. Based on this premise, SSI has garnered some success in fostering discussion on the subject, and finds it valuable to the development of program strategies to examine comments from industry representatives from a local group **after** they had participated in a four-day session on nuclear attack preparedness planning.

To begin, the local participants in this discussion were originally of the impression there was virtually nothing that could be done — not just to protect industry, but to survive. When the civil defense programs of Switzerland, Norway, and Sweden (the latter with shelters established for everyone both at home and at work) are cited as evidence that civil defense is meaningful, and protective measures

can be implemented, they find it difficult in their minds to reconcile this with what they hear and see in the local media. Early impressions of civil defense have been gained from the more vocal groups on the subject, and these have had their impact because there is no organized countering effort to supply more appropriate information. (A grass roots supportive effort would be ideal, but it is unlikely to develop spontaneously.)

However it might be accomplished, once credibility is established among industry decision-makers regarding civil defense and industrial protection, among the arsenal of tools that can be used to develop an effective PIC program are: short range response countermeasures such as shutdown, protective housekeeping, expedient hardening, evacuation/relocation, sheltering; and longer range response countermeasures such as permanent hardening, alternative technology substitution, mothballing, stockpiling. The longer range responses are considerably more expensive and are particularly unlikely to occur without financial incentives in addition to guidance. The short range responses might be promoted initially by effective keying to immediate benefits; e.g., reduced vulnerability to natural disasters; this austere approach is the interim course that SSI has undertaken. It should be noted that even with the economic, political, and technical credibility established, industry has sufficient problems with day-to-day exigencies that adherence to a well defined civil defense program will be necessary to get industry to respond.

Section 3
UTILITIES ALTERNATIVES

Under the current FEMA Integrated Emergency Management System (IEMS), the intent is to build a solid base of management techniques that are pertinent to a wide range of emergencies. One of the more obvious items to consider, for emergencies in general, is that of utilities; for ready availability of utilities is a basic industry requirement for production. Utilities (energy, water, communications, waste disposal) can be disrupted by virtually any emergency situation (earthquake, tornado, hurricane, ice storm, flood, sabotage, nuclear attack), so that alternative options are very nearly mandatory in many instances.

In Ref. 4, industry's electric power and water utility requirements and problems were considered, and alternatives discussed. Herein, the major segment of industry's energy demand, process heat, is discussed, some comments made on communications, and some aspects of industry's transportation problem (not really a utility, but a critical outside service insofar as industry is concerned) are considered.

PROCESS HEAT

Process heat will be very important to postattack industrial recovery; industry consumption of energy for process heat (68% of its total consumption) is approximately twice the energy requirement for electric power. Moreover, 59% of this process heat is furnished as **steam**, with boilers (heat exchangers) the most common method used for steam generation (though a small amount of process steam is produced in conjunction with cogeneration systems that use the exhaust from steam turbines as the supply). Boilers may also be used to supply hot water, but this is an insignificant portion of boiler use.

Either gas or oil fired units are used by the majority of manufacturers. But recently, demand has increased for combination gas/fuel-oil units, and tri-fuel (gas/oil/coal) units that will burn a variety of solid fuels. This is important because a capability to use solid fuel would have important implications in a nuclear attack; the immediate benefits that could induce industry to implement this capability are mainly the economic tradeoffs between alternative fuel prices for cheaper fuel against either the cost of conversion to burn it, or the cost of purchasing fuel versatility when acquiring a new unit. Tradeoff data for decision purposes have not been developed here because fuel costs are a function of the geographical region, and conversion costs depend on the type of boiler to be retrofitted at a given plant, so that it would be a sizable task to develop these data for general use. Moreover, the information would change with time, so that it must be developed at the time of decision. But there is a way to make the task easier for industry.

Some Department of Energy programs already exist to encourage public and private utilities to convert to coal (but none is known that targets industries). A program element to target industries would seem the best way to generate industry interest in developing a fuel alternative capability. Some of the utilities conversion data may be pertinent to industry so that if the DOE were to provide this information, tradeoff costs and benefits could easily be incorporated into integrated emergency preparedness programs. This appears to be a FEMA/DOE negotiation problem.

At present, approximately 40 U.S. manufacturers supply multifuel boilers that can provide the versatility so useful in an emergency (as well as burn cheaper fuels now). In addition to consuming 40% of all industry demand for energy (in supplying the 59% of process heat industry needs for production), boilers require electrical power to operate; this is an important consideration for civil defense planning. The electric power demand of these boilers is significant, so that this major segment of industry process heat demand poses a very real electrical power problem.

Boiler Requirements for Electrical Power Supply

Industrial boilers and heat exchangers require electrical power to run ancillary motors and pumps needed for operation. Typical requirements are:

- o Forced draft fans
- o Pressure atomizing oil pumps, #2 oil
- o Air atomizing compression motors, #2, #4, #5, #6 oil
- o Air atomizing pump motors, all oil fuels
- o Oil heaters for #4, #5, and #6 oils
- o Solid fuel handling and stoking equipment
- o Electric control circuits
- o Electric stoking for all fuels

Thus, electric power is critical to boiler operation, so that for a boiler to be activated in a post-disaster situation, electrical power must be available. The question is, "how much power demand is typical?"

A 50,000 lb/hr fluidized bed boiler requires a 470-amp total connected electrical load, and has a 175 hp equivalent power requirement. Without electrical power available from a public utility, it will require a 250 KVA standby generator to operate this particular boiler equipment. Extrapolating the foregoing data, it requires electric power input equivalent to approximately 1.5% of a boiler's thermal capacity to fire it. As industry's process heat requirements are 68% of its total energy demand, and steam amounts to 59% of this, it appears that 1.5% x 68% x 59% of industry energy use would be required in the form of electricity just to fire all the existing boilers. This 0.6% of the total energy usage corresponds to 0.6%/32%, or 1.8% of all industrial electric power consumption. If supplied entirely by engine-generator units, postattack demand for power to fire boilers seemingly would require many if not most of the engine generators required for other tasks.

> **Unavailability of electric power to fire boilers could become another major bottleneck to early postattack recovery by industry** (along with heavy boiler dependence on liquid, and possibly gas, fuels).

Thus, there is a need to foster installation of standby engine generators and conversions to solid fuel firing capability.

Fluidized Bed Boilers

The increased cost and questionable availability of fuel oils has stimulated research interest in solid-fuel fired boilers, particularly coal and wood fired types. This interest has resulted in major efforts to research and develop more efficient boilers and has led to a corresponding requirement to reduce flue emissions. The research has resulted in development of practical fluidized bed industrial boilers; however, very few are currently in use. Commercial fluidized bed units range from 2,500 to 50,000 lb per hour steam capacity and are capable of multifuel operation including all grades of coal, wood and wood waste, other biomass solid fuels, #2 to #6 fuel oil, waste oils, natural gas, and propane (clearly a desirable versatility for the situation following a nuclear disaster).

Recent government installations of such units have been made on an experimental basis. (This seems a reasonable step toward developing industrial interest.) Units installed include a 50,000 lb/hr fluidized bed at the U.S. Navy Great Lakes Illinois Training Center (which, incidently, can use high-sulfur coal, 2% to 6%), and two 67,500 lb/hr boilers at the DOE Idaho National Engineering Laboratory, Idaho Falls (which use low-sulfur coal). Economic information developed on the operation of these test units could prove valuable as a means to help influence industry to take similar steps.

Multifuel Application to Industrial Plant Operation - In recent times industry has made some investments in fuel conversion. These investments have been made because of new regulatory requirements, increases in fuel costs, deregulation of natural gas prices, and occasional spot shortages of fuels. Most fuel conversions result in one of two industry alternatives: purchasing new multifuel boiler heat exchange equipment, or retrofitting existing boiler equipment for multifuel operation.

New Equipment - Typical of new equipment being installed are multifuel boilers other than those equipped with fluidized beds. These boilers are capable of firing coal, wood, oil, gas, propane, and selected plant wastes, including cardboard, yarn, oil-treated coal, and carpet scraps. A few boilers are designed to burn any combination of gas, oil, coal, and waste, either simultaneously or alternately. These boilers have two stokers, one for solid fuel and one for gas and oil. More efficient

operation occurs when both stokers are used simultaneously. The majority of standard boilers manufactured provide some degree of multifuel capability; e.g., distillate fuels grades 1-4, residual fuels grades 5-6, and natural gas.

Because of air quality requirements promulgated by EPA and increasing problems of plant waste disposal via incineration, some industry interest in solid fuel and multifuel units, primarily to burn coal and plant wastes, is emerging. Coal-fired units, however, often require particulate emission control equipment, especially in boilers above 60,000 lb per hour. Even so, at the present time one manufacturer, Foster-Wheeler, supplies more solid-fuel — wood- and coal-fired boilers — than gas/oil units.

Retrofitting - In general, combustion equipment is commercially available as manufactured package units, although larger units are field erected. Retrofitting an existing boiler/heat exchanger system is often limited to replacing the existing single fuel burner system with a new multifuel burner. In this case, if the plant boiler has outlived its economic life, it may not be suitable for retrofitting. In addition, if the existing system is designed for fuel oil, and consideration is being given to solid fuel conversion, additional costs are involved. Converting firebox boilers to stoker firing (coal or wood) requires removal of the existing burner, elevating the boiler, or recessing the unit in a floor pit to accommodate the new stoker equipment. Developing multifuel capability, i.e., gas/oil, requires relocation of the burner to the rear of the boiler.

> **From a civil defense standpoint, the single most desirable process steam heat option for industry to implement currently to accelerate postattack recovery is a multifuel boiler.** Additionally, postattack preparedness could be facilitated by stockpiling a fuel conversion kit (to solid fuels such as coal or wood) at each liquid or gas fueled boiler facility (where conversion is feasible).

Unfortunately, there are no incentives — at least, none comparable to those offered for alternative power generation — that would cause this to receive industry consideration.

Process Heat Reuse

This may be the major alternative for obtaining process heat via options initiated in the postattack world. Eighty percent of all manufacturing energy is consumed in six energy-intensive industries. (This equates to roughly 15 percent of total national energy consumption.) Many of these individual industries require varying qualities (temperatures) of process heat. Energy conservation in these industries has not been important until fairly recently, and thus, opportunities for energy reuse by cascading from one process to another (at lower temperature) are quite promising. A study of this potential would be valuable for making decisions regarding relocating industry operations in a postattack environment (or, perhaps, even in a crisis relocation period).

Information on this subject indicating its potential was developed and presented in Ref. 5. Figure 2, taken from that reference, shows industrial temperature requirements for typical industries within the six energy-intensive industry groups. The chart indicates significant potential for energy saving exists through the expedient of applying some astute management. Further effort to develop and organize energy storage and reuse opportunities within these industries could benefit emergency preparedness considerably.

The greatest problem in developing energy reuse schemes is that many industries have not developed an energy budget to determine their process heat **quality** (temperature) versus **quantity** needs. With proper scheduling of heat recuperators, industry can reuse high quality process heat at several successively lower temperatures to preheat air, water, feedstocks and to generate electric power.

The recommendation that serious consideration be given **process heat reuse**, by cascading within the major energy-intensive industries, is presented for the following reasons:

(1) Approximately 60% of energy consumed by industry is currently lost as waste heat. Frequently, high quality heat streams (over 2000°F) are cooled to 800°F with water (also jettisoned along with its heat content) in order to reduce the flue gases to a

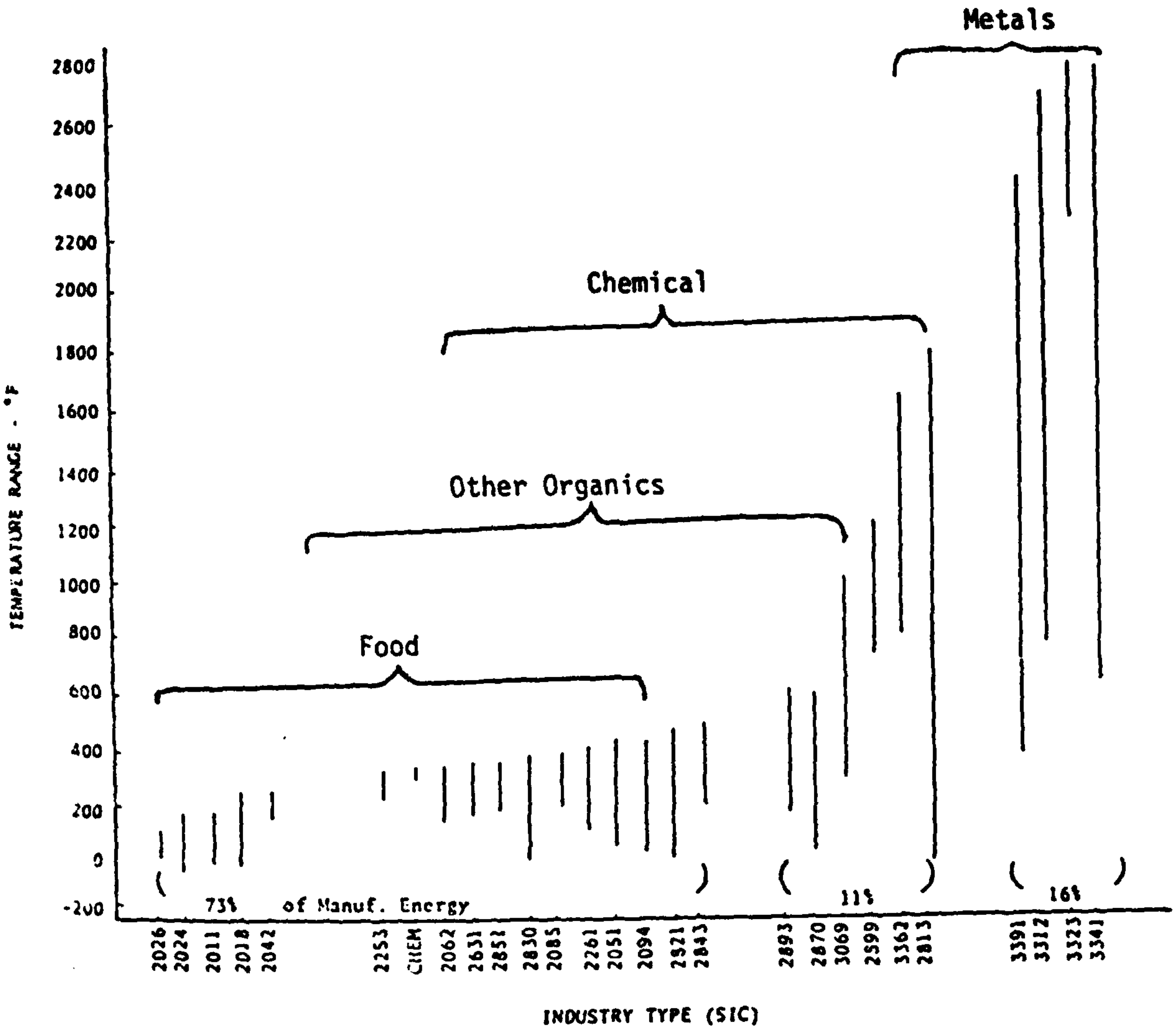


Fig. 2. Industrial Temperature Requirements in Philadelphia.

Source: *Ref. 5, Glenn, D.R., Technical and Economic Feasibility of Thermal Energy Storage, COO-2558-1, U.S. Energy Research and Development Administration, February 1976.*

temperature that can pass through a filter system, before release to atmosphere.

(2) Direct fired boiler efficiencies are not expected to increase significantly in future years (Table 1), therefore emphasis should be on fostering retrofit options for existing boilers.

(3) The near-term potential for energy recovery and use in smaller industries is an important portion of the total reuse concept. The primary uses of steam in the small industry category are food, textiles, paper, and chemicals. Therefore the potential for waste heat recovery is greatest in these four industry sections.

Table 1
Direct-Fired Boiler Efficiencies
(percent)

	1976	1985
Food	80.0	82.0
Textiles	80.0	82.0
Pulp & Paper (fossil)	82.7	83.7
Pulp & Paper (waste)	55.9	58.5
Chemicals	84.0	84.0
Petroleum Refining	81.0	82.0
Steel	80.0	82.0

The magnitude of potential waste heat conversion or reuse can be appreciated from Figure 3 (Ref. 6). In an emergency, at least a part of this waste heat could be tapped as a resource. In 1980, when approximately 20 quads of energy were used by industry, 12 quads were lost as **waste heat** at temperatures **suitable for input to other industries.** (At the same time, 12 quads of energy were used in the residential sector, with 8 quads lost as waste heat; this is another potential source to tap in an emergency.) As the cost of energy increases, waste heat will become more valuable, and further industry effort will be expended in waste heat recovery and reuse using

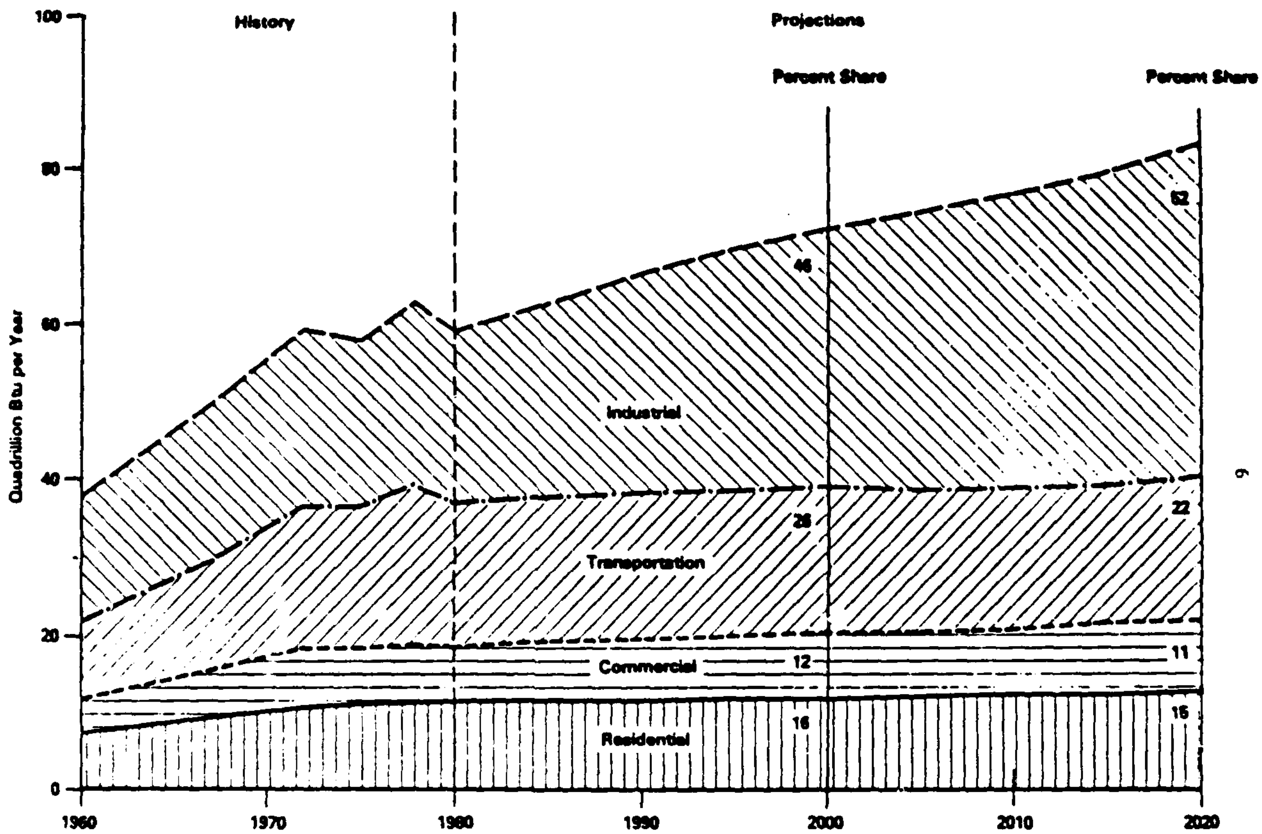


Fig. 3. U.S. Energy Demand by Consuming Sector.

Source: *Ref. 6. Hutzler, M.J., et al., Energy Transition: The Forecasts Through 2020, DOE/EIA-0281, U.S. Department of Energy, March 1981.*

cogeneration, recuperators, cascading, etc. All of these options could be applied to provide additional resources in an emergency.

Reuse and Recycle Hot Water and Steam - Many industries have yet to implement water and steam condensate recycling programs, and this reuse is a significant portion of the existing potential for waste heat recovery (as well as water conservation). There is, however, sufficient technology already to implement and convert the unused hot water and steam for useful production purposes. This could prove very important in a national emergency. Industry has been reluctant to initiate these expensive conversions because of the requirement for duplication of existing plumbing and piping systems to return the condensate to a central location for reuse.

An adequate supply of piping, pumps, and power could make this option attractive in a postattack environment.

Process Heat Summary

Process heat will be important to industry production in the postattack period, particularly because basic energy requirements for process heat are about double that for electrical power. Roughly 60% of this process heat is dependent on steam from boilers. Thus, any alternative schemes for getting boilers on line, postattack, will be key factors in recovery. The most valuable alternative appears to us to be a capability to operate using solid fuels such as coal, wood, and wood wastes. One may expect considerable wood wastes to be available in the postattack environment (e.g., Figure 4, taken when the Olympic National Building was demolished in Seattle, Washington). The major impetus for industry to install solid fuel capability now (either in new equipment or as retrofit) is economic — to take advantage of a lower fuel cost. Provided this offsets the cost of the equipment and has a short-term payback (after taxes), industry may be inclined to make the transition now. Such conversions are much more likely to occur spontaneously in "coal country", but even there it might require incentives to foster a significant number of installations.

Unfortunately, in regions remote from coal supplies (such as the Far West), there is no inexpensive solid fuel to provide the necessary economic impetus for

Fig. 4 . Debris from Demolition of Olympic National Building in Seattle, Washington.

changeover, so that any action (such as stockpiling conversion kits to use in case of disaster) would require Federal intervention (support). Conversion kits seem a logical item to include on the stockpile list (and in the stockpile).

Emergency Fuel Supplies

Rapid industrial recovery from nuclear attack is likely to depend on an accessible supply of domestic energy as well as on the conversion equipment that enable these alternative fuels to be used. From the standpoint of availability in quantity and deliverability, a prime prospect for early and intermediate term recovery efforts of industry would appear to be coal — delivered by water transport.

Coal produced in the United States currently accounts for about 21% of all energy consumed in this country (which is enough to meet 40% of industry needs). In a national emergency, it is possible and probable that coal production would be expanded significantly (it has already been expanded significantly since the oil shortage of 1973). Fortunately, the heyday of coal as an energy source dates back to a time when water transport was a major distribution system. The basic infrastructure remains, so that this particular fuel/transportation combination could represent a significant strategic postattack resource.

COMMUNICATIONS

Effective information exchange is important to commerce and industry, anytime; during and following an emergency, a war, or disaster, it is vital. Therefore, an extremely valuable emergency preparedness asset will be alternative communications schemes that industry could use to carry on vital functions now, in an emergency situation, and in event of a nuclear disaster.

At its simplest, the principal function of a communications utility is to provide transmission links between geographical points located beyond hailing distances; however, the communications aspect of industrial operations (or any human endeavor) far exceeds this simplified picture. The capability to exchange vital information in

timely fashion constitutes the real communications need anytime. So there are two facets to the information exchange problem: the messages, and the mechanics of transmitting them.

Generally, as soon as an emergency begins there is a need to establish special communications networks, possible through mutual aid agreements among industrial plants — where emergencies can trigger whole sequences of small-scale disasters. In an emergency situation, the period for timely information exchange shrinks drastically, and so may the communication links. Confining initial attention to the in-plant (i.e., local) emergency scene, a very important first requirement is to be able to **warn employees** and **direct actions**.

Starting with the premise that the response time is a most critical factor, it is clear that one had best not wait until an emergency occurs to give direction. Preplanning, and communicating information about warning signal(s), evacuation routes, meeting points; establishing procedures to execute head-counts and report missing persons; assigning damage control squads and alternatives, and procedures for obtaining status reports — all of these, if done **in advance**, will reduce the need for communicating *messages* **at the time of incident** (when time in which to communicate is short and communications mechanisms may be in short supply). This preplanning, and training and exercising, are vital parts of the emergency communications problem that should not be overlooked.

Once an incident occurs, it is desirable to have several transmission options. These will be more likely to work in an emergency if they are part of some day-to-day operating system. (If they are important to everyday operations, they will be immediately repaired when defects are experienced, and maintenance staff will be well acquainted with systems' behavior problems and how to trouble-shoot them). The plant paging system is an ideal communication tool for warning of emergencies, and it is best if the loss of the system in one building of a multi-building complex has no effect on the operation in the others. Where the complex is large and outdoor coverage is required, loudspeakers can be linked to the paging system.

The limitations of a paging system are that it operates only **one way** — and

there needs to be a standby power system in case of power outage. An in-plant telephone system that operates independently of the telephone utility will provide two-way communication within buildings that will be completely under internal control whatever emergency might affect the telephone utility, but again it requires standby power in case of a power utility outage. For exchange of information in large complexes where key people are outdoors, two-way radios (walkie-talkies) will serve the need for two-way communications both within and outside buildings. And, sirens and alarms can also be made to serve both inside buildings and out, as one-way backup warning systems (and for some operations, e.g., where earplugs are worn, background noise is too loud, or employees are deaf-handicapped, tiers of flashing lights are sometimes used).

All of these systems (excepting the flashing lights), plus a company based radio transceiver, have been implemented at one plant (locally) as valuable assets for coping with areawide and regional emergencies, in addition to in-plant ones. This same plant is also studying communications options that can be used when a crippling regional emergency occurs and the situation lasts for more than a matter of hours. (The particular concern is for a major earthquake that could result in a prolonged emergency, perhaps for days.) In this event, it is desirable for this nationwide, critical defense industry in communications to be able to contact other plants in its corporate domain to request resources and/or support and to shift production responsibilities judiciously. Its investigations show that in large scale emergencies, the public telephone utilities automatically dedicate lines to emergency services, which has the effect of reducing commercial traffic, at best, and eliminating it entirely, at worst (if some or all of the lines are damaged). To this company, such a situation would be intolerable. Together with additional industries (all of which are members of a local mutual aid group) an effective solution is being sought.

A readymade solution is provided in the approach taken by a local emergency service group (the San Mateo County Area Disaster Office, or ADO), which has established microwave links in the area it serves to deal with the situation of telephone lines being unavailable. A local mutual aid group, the South County Industrial Emergency Council, counts the chief executive officer of the ADO as one of its members; the Council, which has recently shortened its name to Industrial

Emergency Council (IEC) to reflect a wider geographic representation, is an organization consisting of industry and government agencies that plan and work together to deal more effectively with emergencies in the community. IEC plans to augment the ADO communications capability and maintain member contact in a regional emergency, for mutual aid purposes, by establishing the following.

It proposes to obtain a radio channel assigned exclusively to it to provide direct links to members in a major emergency. It will keep contact with fire and police services by having their emergency service channels available on these radios as well. It intends to keep the industry group linked to whatever corporate facilities they have that are located outside the region through a microwave link to another member facility that already has a satellite dish. With this system, a couple of communication channels to other regions can be maintained exclusively for industry traffic, even if all the local telephone lines are out.

The importance of such a system should not be underestimated — some of the other industry members of IEC are also critical defense industries. Certainly, in a nuclear attack, it would be in the nation's best interest for nationally based industries (particularly key defense industries) to maintain communications regarding status of conditions so that an optimum recovery could be effected. A whole network of similar systems, established in other communities, could enable critical communication links to be maintained among industries throughout a national disaster in event the telephone lines were unavailable. Thus, the following seems true:

> **Fostering development of similar mutual aid groups with comparable capabilities, including emergency communications links, could be a major force for survival and recovery of industry and the nation, in case of a nuclear attack.**

It would seem that through the approach of establishing many such mutual aid groups involving industrial members, additional industries might be influenced unobtrusively to prepare for breakdown of normal communications by relating this problem to preparedness for a regional disaster, such as an earthquake or hurricane, where telephone and power lines may be downed.

Assuming a nuclear attack scenario involving Crisis Relocation, in the period immediately following relocation but prior to attack, communications to key workers in the risk area will be very important — particularly with regard to providing warning information or requests for specific material or personnel support to be delivered by the next shift change. A communication link will need to be established directly to (or from) the key worker shelter (which will not, generally, be equipped with a telephone system) so that it will be exercised regularly in the crisis period as preparation for the postattack recovery period. Thus, portable radio transceivers to link the host and risk area contingents of operating industries will be a must. A certain number of such units will also prove valuable tools to any company that wishes to prepare for natural disasters, such as earthquakes — or contingencies such as in-plant hazardous materials spills or fires in the event telephone lines are lost. Establishing a basis for determining an optimum number of units will be one of SSI's future objectives. Continuing contact with those industries in the forefront of this type of preparedness (among IEC members) will enable empirical information to be developed on a continuing basis as the plants evolve their own (everyday, practical) systems to meet various needs.

In the immediate postattack period, communications will be restricted because of changes in the environment; that is, while people are confined to shelters for survival, communications will be limited principally to military and political traffic — perhaps, with some exchanges of information between nearby communities on local conditions, with damage functions prevailing. For the most part, industry requirements in this phase would be covered by the transmission links between host and risk areas. In the subsequent post-sheltering period it will be important to assess conditions and to exchange information in status reports. With a surviving microwave link and satellite system (such as described earlier) in place in many communities, this early need could be met. But, shortly after the initial assessment and reporting of status, it will be necessary to start recovery operations to put additional essential industrial facilities back into operation. At this time, communications vital to commerce will need to begin.

If it can be assumed that a large part of industry's demand for high speed communications today stems from competition for markets — and to acquire status

reports and economic data to achieve tighter inventory control to save dollars — these priorities will cease to be major concerns. Hence, this economic requirement for timely exchange would reduce virtually to zero. However, any capacity gained here would likely be offset during the recovery period when it would be expected that more communications than normal would be required by industry to locate new sources of information, supplies, etc., to replace those lost. At least some of this will have to be done fairly rapidly, probably by telephone. As telephone transmission links are resurrected, they will very likely have to be dedicated to military, political, and industrial traffic for some time, at the expense of personal use. At this stage, then, options that industry can implement unilaterally cease. Dispensing with personal use may be expected to reduce demand considerably, but even with the exercise of this management expedient, capabilities may fall short of demand in the early recovery period.

After the early recovery period, while telephone, radio, and satellite communication links are still insufficient, there will be little to serve industry as effective transmission systems, excepting the mails (perhaps again at the expense of personal communications). Mail may prove suitable for some purposes — after all, mail is used now for a great deal of commerce and industry, with a week to ten days for receiving replies not uncommon — but it is a poor match for what industry will need in the early going. However, it is likely that a two- to three-day one-way service would suffice, in many instances, in the mid-period of industrial recovery, once routine production commenced.

While communications are critical and systems in short supply, all physical delivery modes (or combinations) would be possibilities: air, rail, ship, barge, truck, bus, car, dirt bike, bicycle, foot traffic; but to make these systems viable would, in itself, require some communications; i.e., the developing and transmitting of information about route feasibilities. Such data would undoubtedly be acquired in conjunction with reestablishing transportation systems, in any case. In addition, it should be possible to lay field telephone lines along railroad tracks fairly readily, if a system were designed in advance and quantities of field telephone wire stockpiled.

Communications Summary

Regarding the communications problem industry would face in a nuclear attack, it appears industry can do much to improve its lot. Fortunately, the same capability would serve industry in a major natural disaster, should telephone communications systems cease to function. The implication is that an integrated systems approach should be used and emergency communications for natural disaster (e.g., earthquake) preparedness fostered. If the crisis period is prolonged (which could occur in either disaster — nuclear or earthquake), communications will be particularly important to essential industries that continue to operate facilities within the affected areas. For both these situations, communication systems independent of telephones and their vulnerable lines are a necessity. Portable transceivers with a 20-mile range would serve in a prolonged crisis period. Such units would be adequate to link host areas with key workers, would be invaluable during evacuation, and would also serve very well at any time as an in-plant communication link to key personnel to be called (from home) in event of a local emergency (plant fire, hazardous material spill, etc.). These units would also serve as building-to-building links intraplant. Development of regional communications links using microwave and satellite are possibilities that industries with plants nationwide may very well wish to consider. Undoubtedly, there are a few such industries in every major industrial area so that other industries in the same area would benefit. A significant strategy for dealing with the industrial communications problem unobtrusively would be to foster development of local mutual aid groups on the pattern of IEC and the development of effective exchange of information among them.

TRANSPORTATION ALTERNATIVES

For industry to operate anytime, it is essential that a variety of transportation needs be satisfied. These include providing for the movement of materials, equipment, personnel, repair parts, and supplies to a myriad of work sites, and movement of whatever is produced to consumers. There are several measures that industry could implement that would improve the availability of transportation in emergency periods such as would follow a nuclear attack or a natural disaster.

Vehicle Pre-positioning for Emergency Use

The first option to implement is one that will improve the survivability of vehicles. In an emergency period such as might precede a nuclear attack (or a hurricane), industrial facilities should implement contingency plans to relocate vehicles from probable disaster areas to safer host areas. As long as the vehicles are moving out anyway, critical equipment could also be relocated to host areas as a hardening option at the same time. If the host areas are to have the necessary fuel and maintenance capabilities, these will either have to be pre-established, or be moved to host areas with the vehicles as part of the loads. The contingency plans should consider all facets of the transportation problem.

Emergency Fuel Supplies

Many industries have their own supplies of fuel for their own vehicles. Gasoline and diesel fuel are stored in tanks, normally underground, and pumps are provided for filling vehicle tanks. Following a severe emergency, supplies of fuel at main plant sites, especially in urban areas, may be destroyed or inaccessible, and power will probably be unavailable for operating the pumps. However, if auxiliary supplies are available in satellite locations in rural (host) areas, and the electric power is backed up by an onsite generator, these may remain available for essential uses and could mean the difference between satisfying emergency transportation needs with resources on hand and being totally dependent upon others.

Options can be set up by industry, but one that would likely require government approval, would be to use tankers with transfer pumps to tap the fuel supply remaining in surviving gasoline stations, fuel storage yards, tank trucks, rail cars, pipe lines, etc. A major repository for reserve supplies of gasoline, for example, might reside in storage tanks of fringe (partially damaged) area gas stations.

Transportation Summary

Transportation will be a critical item for recovery of industry postattack. Unfortunately, there is no clear alternative that industry could implement, let alone draw a current benefit from, that is not already in place. The protective measure of moving trucks (laden with vulnerable equipment and records) out of risk areas has already been addressed in the self-help guidelines (Ref. 1), and most companies that

purchase or lease fleets already acquire identical units for easy maintenance and repair. What the analysis of industry's transportation needs for recovery has indicated is that it would seem mutually beneficial if government established some procedures that will be used in a national emergency, and identified some of the areas where responsibilities might be shared, directed specifically at clarification of roles. This sort of thing is beyond the scope of a self-help Industrial Protection Manual.

Section 4
TOXIC MATERIALS MANAGEMENT

In the section of Ref. 4 that deals with this topic, the following items were treated:

- The general problem of shutting down and hardening those operations that involve toxic or hazardous materials was treated in relation to preparing for a major emergency, e.g., a hurricane or nuclear attack.
- A decision-tree flow chart was developed to aid in the identification of options that industry could implement that would lead to fewer spills of hazardous and toxic materials in event of a major disaster.
- Suggestions were made for an integrated government-community-industry program that could make post-disaster recovery easier and safer.
- The concept of integrating emergency planning and preparedness at the level of the individual plant was discussed — in general terms of benefits that might be gained for nuclear attack preparedness from implementing countermeasures appropriate to other types of disasters.

In this section, one example of the latter item involving a specific overlapping benefit is analyzed quantitatively. This quantitative assessment of the integrated emergency management systems approach applied at the **industry level** is interpreted in terms of benefit to nuclear attack preparedness.

The example is taken from a local problem of considerable concern. A survey of industrial plants in the IEC (local mutual aid group) area has shown that materials are quite often stored in elevated tanks and that hazardous materials are included. Generally, an elevated tank design is used to take advantage of gravity for

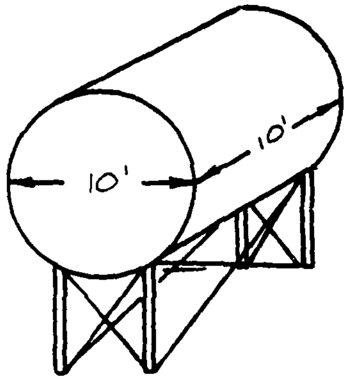
transferring liquids. Recent concern of industry members about the effect of a major earthquake on such tanks led to the examination by SSI of tank and support structure vulnerabilities. The overlapping benefits to nuclear disaster preparedness from solution to this problem was of interest to FEMA/SSI, so vulnerabilities to earthquake, wind, and blast-wind forces were investigated.

The approach taken was to calculate the load resistance of a typical tank and support structure found in the local area, then calculate the stiffening of the tank support assembly required to prevent its collapse due to earthquake ground motion forces (and then to tornado and hurricane winds). The full tank case was used because it is the "worst case" from an earthquake point of view (but the best case for resistance to hurricane or tornado winds or to a nuclear disaster). It is also readily realized in a matter of hours, simply by filling the tank with any liquid compatible with the original contents. By calculating the resistance **change** to wind loading that resulted from **adding the earthquake upgrading measure**, the benefit of the earthquake upgrading was related to airblast from a nuclear attack.

The airblast calculations assume response is to the peak value of the wind velocities (i.e., the peak dynamic pressure, rather than the dynamic pressure impulse, which also depends on pulse shape and duration). Figure 5 shows the configuration analyzed and summarizes the calculations for both earthquake and wind forces. The wind force at failure can be related to the static overpressure from a blast wave (e.g., Refs. 7 and 8), and through the explosives scaling law, overpressures, p, can be related to distance from explosion, d, and charge weight, W, as:

$$p = f(d/W^{1/3})$$

and the relative sizes of the regions reaching the overpressures corresponding to the two wind velocities before and after installation of the stiffening will provide a measure of preventable tank failures.



VOLUME = 785 CU.FT.

NON-SEISMIC ORDINARY WIND DESIGN	SEISMIC DESIGN
• ULTIMATE HORIZONTAL FORCE = 3376 LB	• ULTIMATE HORIZONTAL FORCE = 33,000 LB
• ULTIMATE WIND UNIT LOAD 33.8 PSF	• ULTIMATE WIND UNIT LOAD CORRESPONDING TO $\frac{33{,}004 \text{ LB}}{100 \text{ SQ. FT.}} = 330$ PSF SIDE ELEVATION AREA
	• $P = 330 \text{ PSF} = .00256V^2(.8)$
• V = 115 mph = ULTIMATE WIND SPEED	• V = 401 MPH ULTIMATE WIND SPEED.

Fig. 5. Blast Resistance of a Tank Built to Seismic Specifications.

Section 5
RAPID SHUTDOWN

Some of the basic problems associated with rapid shutdown were discussed in Ref. 4, where major damage mechanisms were identified and an 8 x 13 matrix was presented of these damage mechanisms versus major industries affected. Among the most damaging mechanisms are those that can trigger subsequent emergencies and expand the disaster through initiation of explosions and fire, while among the material processes, the most critical are those that involve hazardous materials, because they pose significant threats to life and to safety. To provide some insight into the problem, in Ref. 4 a generalized shutdown schedule or flow chart was developed for processes in general, and shutdowns involving hazardous materials were treated in terms of a branching flow chart, which indicated options as a function of a condition assessment.

Since completion of the work summarized in Ref. 4, a number of shutdown procedures have been acquired from some critical industries (not listed in the original matrix) that are subject to rapid shutdown problems (e.g., manufacturers of military communications and recognition equipment). In the Crisis Relocation period (or in a prolonged period following crisis relocation), **any** operating plant subject to the possibility of an expanding sequence of damage mechanisms triggered by rapid shutdown will pose a special threat to itself and neighbors. This becomes apparent when consideration is given the question of response time available after final warning to take shelter — it may not be sufficient to execute a proper shutdown without suffering damage that is self-generated.

Discussion of shutdown procedures with plant safety personnel indicated that some plants recognize three distinct types of shutdown. These may be: **routine** (as for scheduled maintenance); **emergency** (with critical items automatically switched to standby systems); or **emergency evacuation** (possibly with automatic switching, but requiring complete shutdown as soon as possible to ensure safe exit of personnel,

tempered by the need to eliminate subsequent repercussions from unattended operating equipment). The latter two are the shutdown procedures of interest for gaining insight into the immediate problems that would be associated with a nuclear attack. But even though the immediate problems are a major concern, they are not the only concern of industry.

Another factor industry must consider in establishing shutdown procedures is that any assessment of emergency shutdown must consider the question and problems of rapid startup. For example, it may take an hour to get back up to 90% production followed by another eight hours or so to get back to 100% production from one type of shutdown, while it may take eight hours to get back to 90% production and days to get to 100% by another, faster, shutdown. As the longer startup will generally be associated with the need for more repairs or maintenance to get back on line, rapid shutdown insofar as industry is concerned is determined by what it would lose in the way of production, equipment, dollars, from the slower startup associated with the faster shutdown. In the risk areas this difference in damage may be insignificant with respect to the damage expected to occur from the blast wave, but in host areas where entire plants have a good chance to survive, improper (too rapid) shutdown might have serious consequences.

A coordinated industrial shutdown strategy has never been discussed with regard to civil defense, but at least one strategy appears to provide some direction to guide shutdown studies, in general. The strategy is one of least number of critical facilities damaged overall. Under it, key industries in the host area that cannot endure rapid shutdown would initiate shutdown early enough to complete the task. Similar production facilities located in the risk areas would be kept operating wherever it was expected that a blast wave would do more damage than late shutdown. If an attack never occurred, nothing would be lost. If one did occur, operating plants in the risk area would be the most likely to be lost anyway. This approach takes cognizance of the possibility that failure to shut down a critical facility (subject to shutdown damage) may be the principal cause of damage if an attack does occur. With this general strategy, shutdown procedures in general become of interest as a means to develop a shutdown guideline.

Table 2 indicates some standard and emergency shutdown times versus a dozen different major industries. These times range from hours to days for standard shutdown and minutes to a day for emergency shutdown. Not indicated on the table are the many plants that have problems with shutdown and do not have even a procedure, let alone a time schedule. The long shutdown times indicate the importance of and the need for establishing a shutdown deadline for different industries (particularly those that must operate through the crisis period) so that the task can be either completed before sheltering, or integrated with onsite shelter access.

The lack of emergency shutdown procedures at many plants points up the need to influence industry to develop such shutdown procedures as a first step to an integrated emergency management system — simply because there is such a variety of emergency situations that can result in a power outage. When developed, the information will enable a better appraisal to be made of the overall shutdown problem in the face of a potential nuclear attack. A factsheet developed for industry use and a segment of a planning manual covering plant vulnerability assessment and countermeasures for power outages are included in Appendix A. They are part of an industrial emergency preparedness planning manual developed by SSI to cover a broad range of emergencies. The manual constitutes the initial step in developing a guideline to an integrated emergency management system at the individual plant facility level.

Table 2

Summary of Shutdown Times for Major Industries*

Industry	Standard Shutdown Time	Emergency Shutdown Time
1. Tire	2-4 hrs	1 hour
2. Synthetic Rubber (Styrene Butadiene Rubber)	2-24 hrs	4-8 hrs
3. Butadiene	24 hrs	1-2 hrs
4. Thermal Power Plants		
- Boiler	24 hrs	
- Turbine	48 hrs	
5. Alumina Refinery	48 hrs	
6. Aluminum Smelter	2-4 days	6 hours
7. Pulp and Paper	6-8 hrs	
8. Food Processing		
- Canning and Preserving	2-4 hrs	
9. Sugar Refining	2-3 days	
10. Glass	2-3 days	24 hrs
11. Petroleum Refinery	48 hrs	0.25-12 hrs
12. Steel		
- Blast Furnace	1-3 days	
- Open Hearth	8-10 hrs	

* derived from Ref. 9, Volume I.

Section 6
EQUIPMENT INVENTORY

A nominal list of common production elements, defined as those likely to be found in virtually any plant -- and found there in quantity -- was initially developed and presented in Ref. 4. The significance of such items is that they are nowise unique -- hence, not items critically in need of hardening during crisis relocation, because similar items or substitutes can be found almost anywhere. This is in contrast to unique items, which are extremely critical to production and must be hardened to prevent development of production bottlenecks, postattack.

Two aspects to this line of direction are to be considered in developing an equipment inventory for common production items (and these link to yet a third):

(1) Assessing the extent of the supply of the various common production elements in use and how they are distributed -- to discover end-users, where they are located, and quantities in use (versus specifications).

(2) Developing a catalog of this information organized by item sources versus geographical location -- for use postattack.

(3) Assessing the quantities of each common item expected to survive an attack by examining outcomes versus location for one (or more) attack scenarios -- to provide insight into quantities and types of items to stockpile (based on shortfall).

This particular task arose from the realization that the equipment requirements for essential purposes in the postattack recovery period probably won't be met by the remaining stocks of new equipment and the surviving capital goods production facilities together. Thus, if it is to be met, there will need to be a mechanism for the transfer of equipment from "non-essential" purposes to "essential" purposes.

Though it is comparatively easy to conceptualize a cataloguing system that is national in scope, unless some simplifying scheme is developed it could easily entail such extensive requirements for the collection, storage, and dissemination of industrial equipment characteristic and location data as to be possibly impractical. A more rational and workable approach might be to develop localized systems — on the county and possibly on the State level. This concept will be evaluated in the next phase of the program.

One alternative SSI considered involved using data collected for some other purpose to determine whether it would suffice. With this in mind, the equipment information in Ref. 4, collected from seven industrial plants for energy audit purposes, was examined. (These data are also proprietary and difficult to obtain.) For our purposes, four of the plants were considered involved in very essential production (three food processors and an instrument manufacturer) while the remaining three plants, which made decorative structural products, hats, and plastics, were considered to be involved in relatively inconsequential production.

For each of these plants, complete data on all operating equipment were available. In Ref. 4, only the three most prevalent common production items in-plant were organized and listed in the table developed. For the three categories of equipment: compressors, pumps, and fans, each entry provided a general name (e.g., exhaust fan) and operating voltage, phase, and amperage or horsepower information (also the lack of information regarding additional specifications, such as intake and discharge pipe sizes, etc., were noted).

Utilizing the reported material, some attempts have been made to assess the match of equipment characteristics between essential and non-essential plants. For example, if an essential plant listed a 20 horsepower, 440/480 volt, air compressor, this demand could be satisfied with an identical, or slightly higher horsepower air compressor with the same operating voltage from one of the less essential plants. Not all operations in a plant engaged in essential production are actually essential. Plant managers have pointed out more than once that the obvious change in priorities in a postattack environment negates totally the importance of cosmetic and economic

requirements of marketing/production. Therefore, additional matches would be possible using these no-longer-essential resources within so-called essential industries.

The matching technique applied for this assessment was strictly of the paper and pencil variety. In Table 5-3 of Ref. 4, the equipment items were listed in order of increasing horsepower, with a separate column for each of the individual plants, and with all plants involved in essential production grouped together in the four left-hand columns. We assumed that this random selection of plants from all over the western United States could just as well be found in one geographical region. Equipment items were then compared between the "non-essential" and "essential" plants to see what sorts of matches could be found.

With the limited equipment inventory represented by these data, it was not possible to match each essential item with an apparently suitable replacement from a non-essential plant. For example, in the compressor category, a total of 89 compressors were listed, but 60 of these were already located in the four essential plants. Of the 29 "non-essential" compressors, apparently suitable matches to "essential" compressors were found for 17; i.e., slightly over 28% of the 60 essential units might be replaced from the three non-essential plants. Of course, some of these potential matches may turn out to be incompatible. On the other hand, one needn't necessarily assume that all of the compressors in the essential plants would need to be replaced (that is, needed under the changed priorities). Also, a lot would depend on where these industries were located relative to the weapons laydown. All, some, or none of the plants might survive intact, or be totally destroyed. (Some effort to examine this kind of question has been initiated recently and is discussed in Section 11.)

Since the data presented in Ref. 4 were collected, four additional plant equipment inventories have been obtained. One of these is from an energy audit of a small steel foundry, one is a set of design specifications for a chemical plant, and two are from plant engineering records of electronics firms. The most detailed inventory is that from the design specifications for the chemical plant, and this is reproduced in Appendix B. From an examination of that data one concludes there is

enough detail supplied to make a decision whether a particular item is a suitable substitute for a damaged item of equipment.

The two sets of equipment inventories obtained from existing plant records have the least detail (but, apparently enough for current plant uses). Table 3 and Figure 6 are extracted from eighty pages that summarize what equipment is in one of these plants. It is clear from these data that the inventory provides very little in the way of specific information of the sort needed to make the kinds of comparisons that were possible with the energy audit data, and that would be needed to make the appropriate selection. Many hours would have to be spent to obtain the missing detail on the specifications for each item listed at just one plant in order to have enough information for a catalog.

What this study of the equipment inventories of so-called essential industries (i.e., those involved in important operations of a military or survival and recovery nature) has demonstrated is that all the methods and approaches examined to date lack practicality; the task of fashioning the information into a useful catalog format is simply unreasonable in magnitude. An alternative approach is discussed in the next section.

Table 3

Equipment List

South Tank Farm

Tank 301
Tank 302
Tank 302
Tank 303
Tank 304
Tank 305
Tank 306
Tank 307
Tank 308
Tank 309
Tank 310
Tank 311
Tank 312
Tank 313
Tank 314
Tank 315
Tank 316

Pump No. 1
Pump No. 2
Pump No. 3
Pump No. 4
Pump No. 5
Pump No. 6
Pump No. 7
Pump No. 8

South Tank Farm

Heat Exchange Pump No. 5
Heat Exchange Pump No. 6
Heat Exchange Pump No. 7

East Underground Solvent Tank
Center Underground Solvent Tank
West Underground Solvent Tank
East Solvent Pump - Minimum 5 pts
West Solvent Pump - 265 Thinner

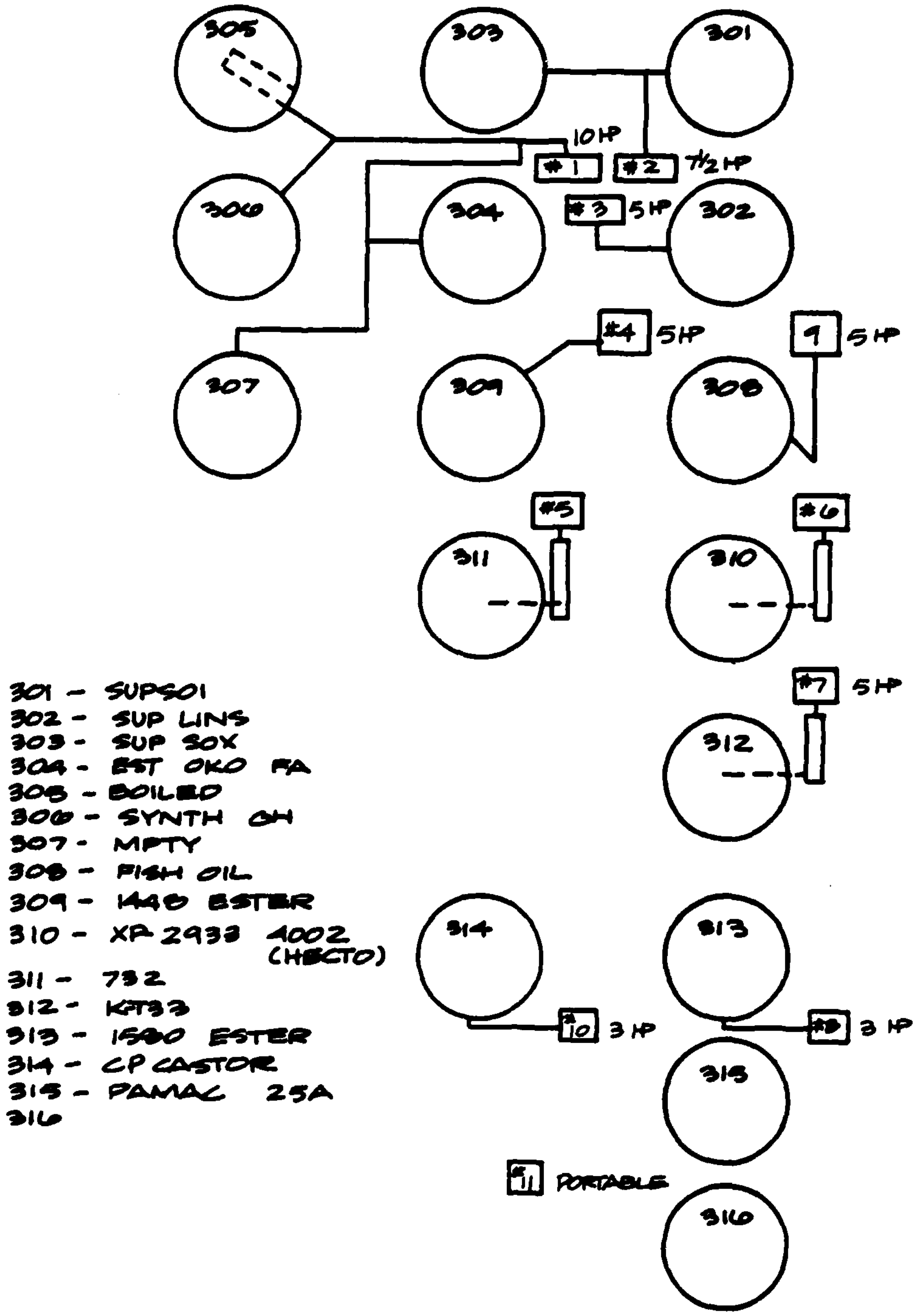


Fig. 6. South Farm Tank Layout.

Section 7
CATALOG OF SOURCES OF COMMON PRODUCTION ELEMENTS

A concordance of common production elements with their end-users would provide a valuable directory for finding replacement items needed to accelerate industrial recovery, postattack. The ideal directory would provide a catalog complete with specifications sufficient to select replacement items. Appendix B, however, demonstrates how much data would be required to provide sufficient detail for selecting common production elements associated with various production phases in just one plant. Moreover, similar data would have to be assembled from many plants and then reorganized to list, under each piece of common equipment, all the plants with similar items if it is to have much utility. Organization of such a large body of material to facilitate sorting by equipment item and with common specifications of capacity, temperature, pressure, pipe sizes, power requirements, etc., does not appear practical.

Analysis of a number of facilities indicates that, to a large extent, most facilities have very similar materials handling equipment for moving raw materials into, and finished materials out of, the plant; i.e., forklifts, cranes, conveyors, bins for materials that arrive in a dry state, and pumps, pipe and hose, meters, tanks for materials that arrive in a liquid state. Essentially similar materials handling equipment will be found where the finished product leaves the plant. Thus, dividing industries into wet and dry operations (or both), and further subdividing into several weight or flow rate categories would be feasible and still make a practical contribution towards reducing the number of industries to be searched for replacement units insofar as materials handling is concerned (a fair portion of the common production item inventory). For materials processing involving common production items, the development of an appropriate process flow chart is the best means for developing a list of industries with common items by applying the procedure described in Ref. 4 and defining common production elements at each stage.

In the last technical status report, it was pointed out that a number of process flow charts were already developed for another purpose (Ref. 9). However, most industries are not included at all, so that many options for identifying scavengeable sources of equipment will be missing. Moreover, comparison with a more detailed process flow chart (see Table 4, developed by a process engineer on the SSI staff, and Table 5, from Ref. 9) suggests that a considerable portion of process information might be missing from the flow charts that do exist. Consequently, it will be necessary to obtain updated or revised versions of as many of these as possible, or develop new ones, if significant progress is to be made.

In the interim, flow charts for a half dozen companies in the local area (San Francisco Peninsula) considered to be involved in production of the more essential survival and recovery items (according to a consensus of a dozen research studies on the subject, summarized in Ref. 10) have been reproduced from Ref. 9 as Tables 5 to 11. Interest in these particular flow charts (and industries) stems from a new task under the program to assess industry in some target region with regard to estimates of damage suffered and recovery expectations — expressly with the intent to identify the potential effect of scavengeable resources on recovery. The initial effort is described in more detail under Section 11, and it is planned to follow that up by visiting some of these facilities so that we can compare actual processes with the schematics here, and identify at each stage what the common production elements are for the industries represented by the flow charts in Tables 5 to 11. Table 12, compared with Table 11, provides an example of the similarities of processes that can be found between different industries.

Table 4

Primary Production of Aluminum Flow Chart

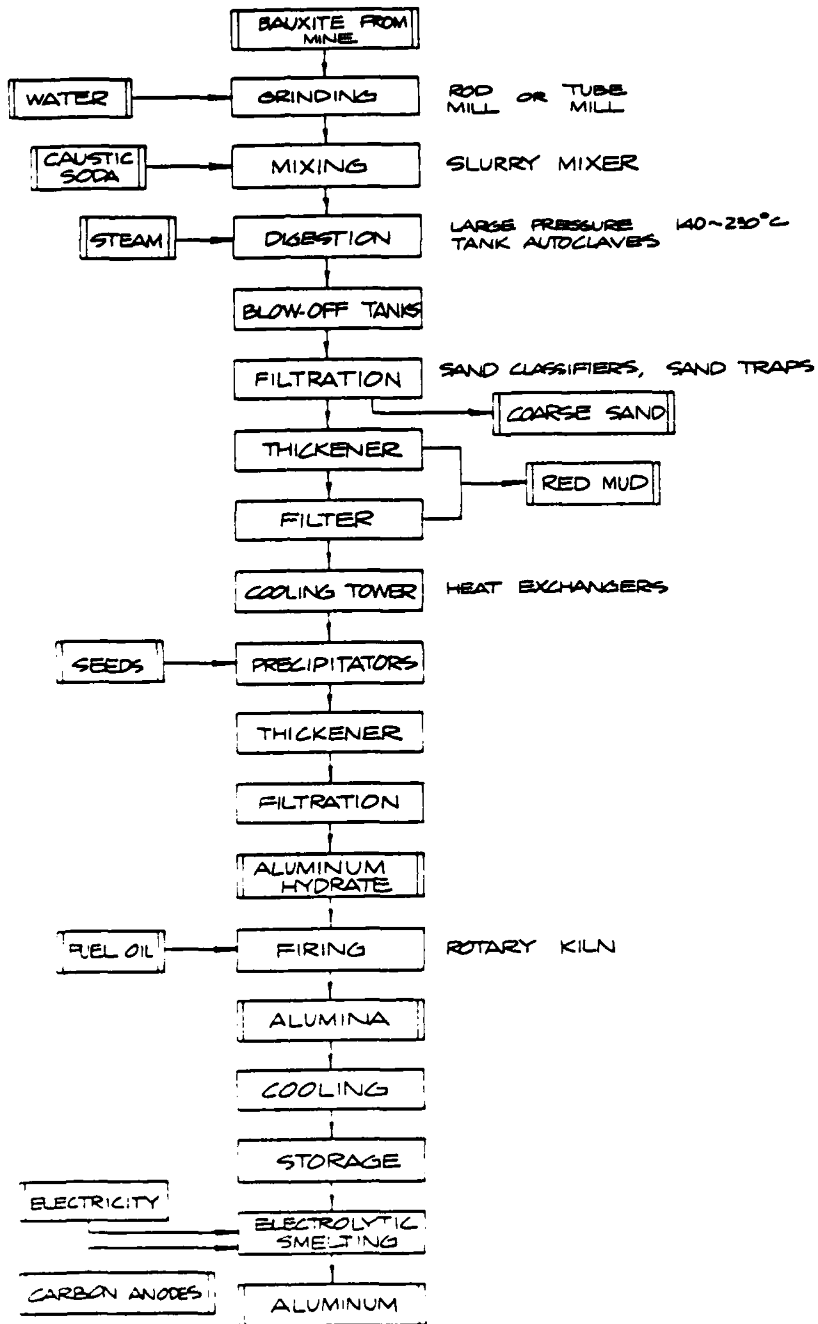


Table 5

Primary Production of Aluminum Flow Chart

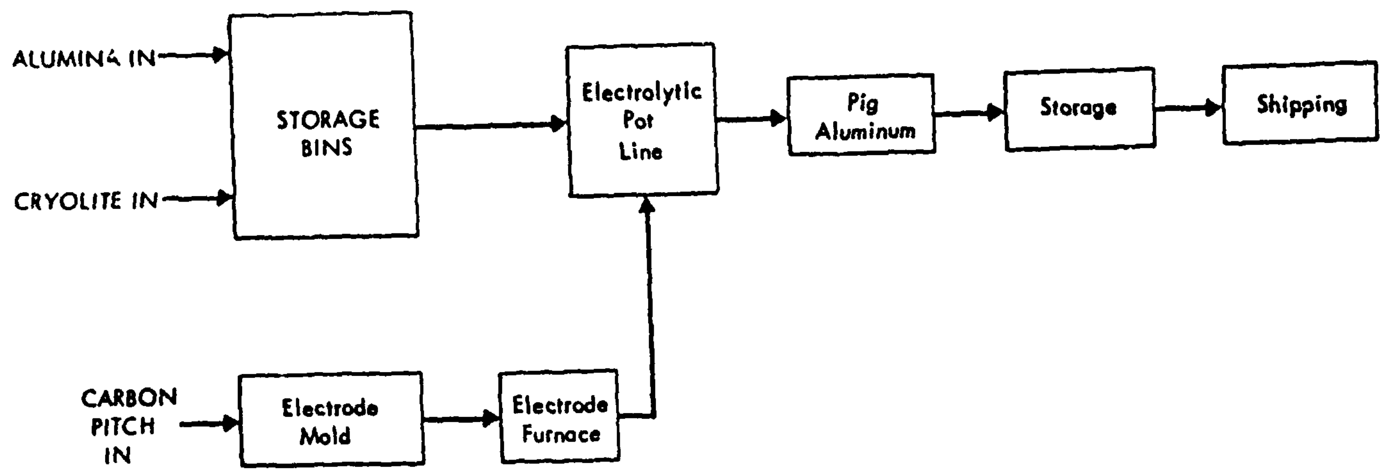
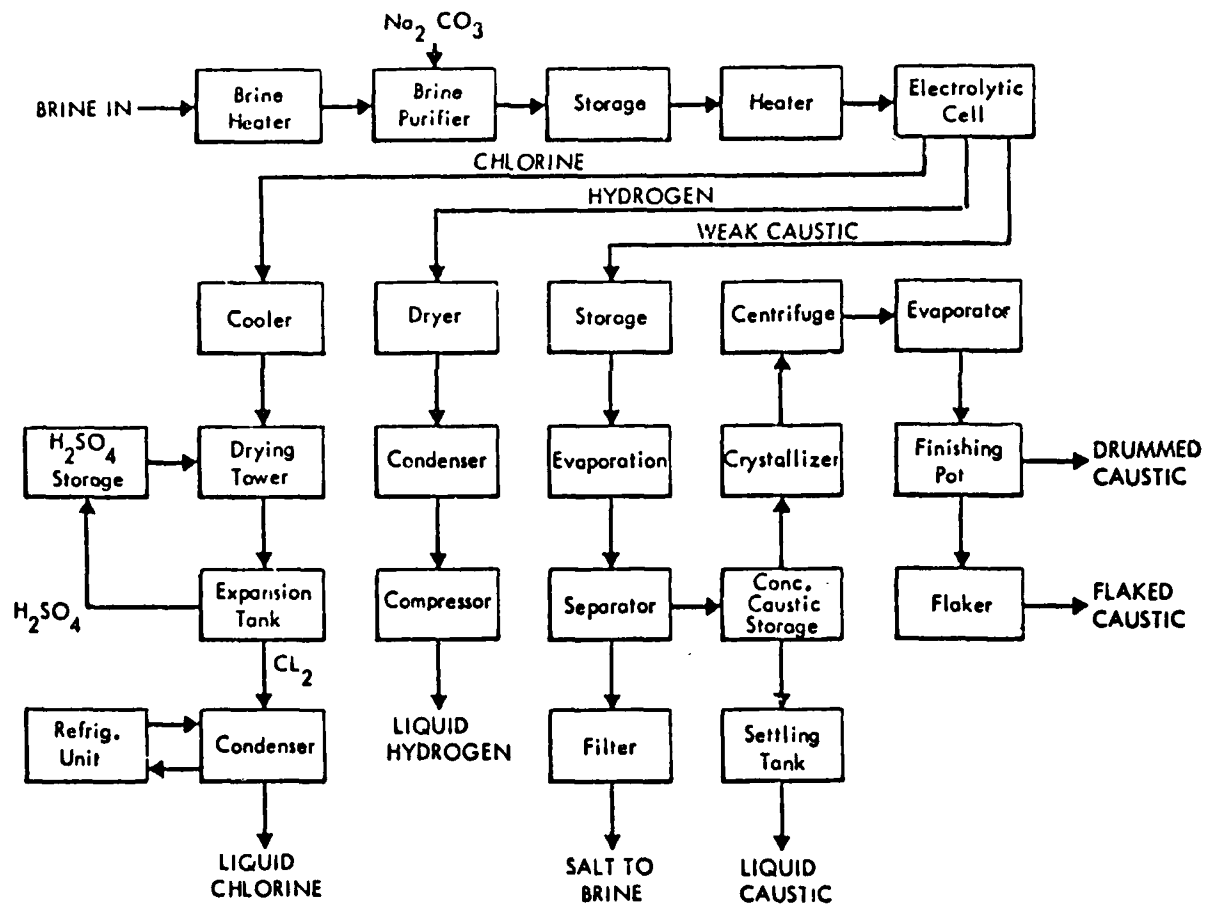


Table 6

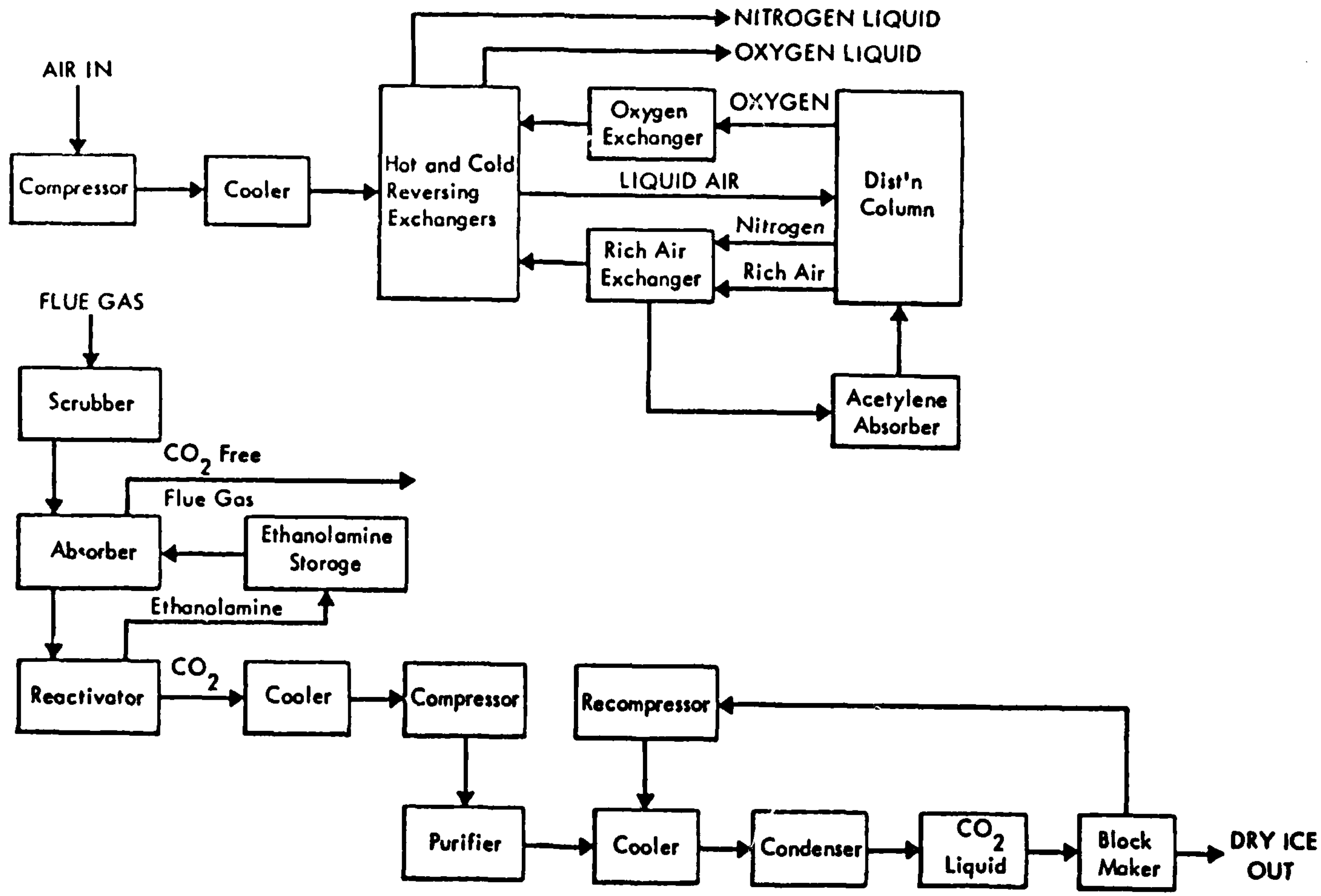
Alkalies and Chlorine Manufacturing Flow Chart



Industry Code 2812

Table 7

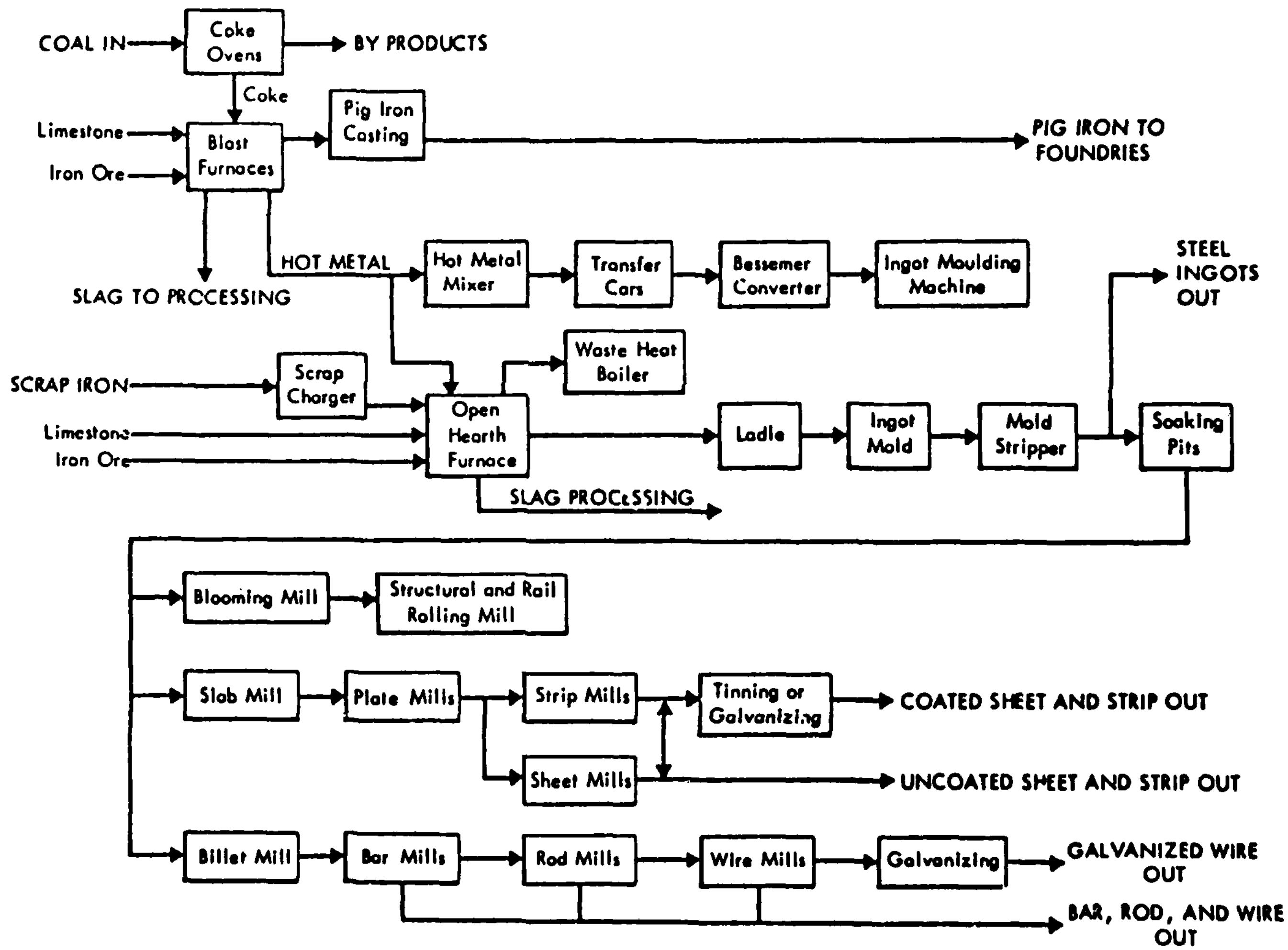
Industrial Gases Manufacturing Flow Chart



Industry Code 2813

Table 8

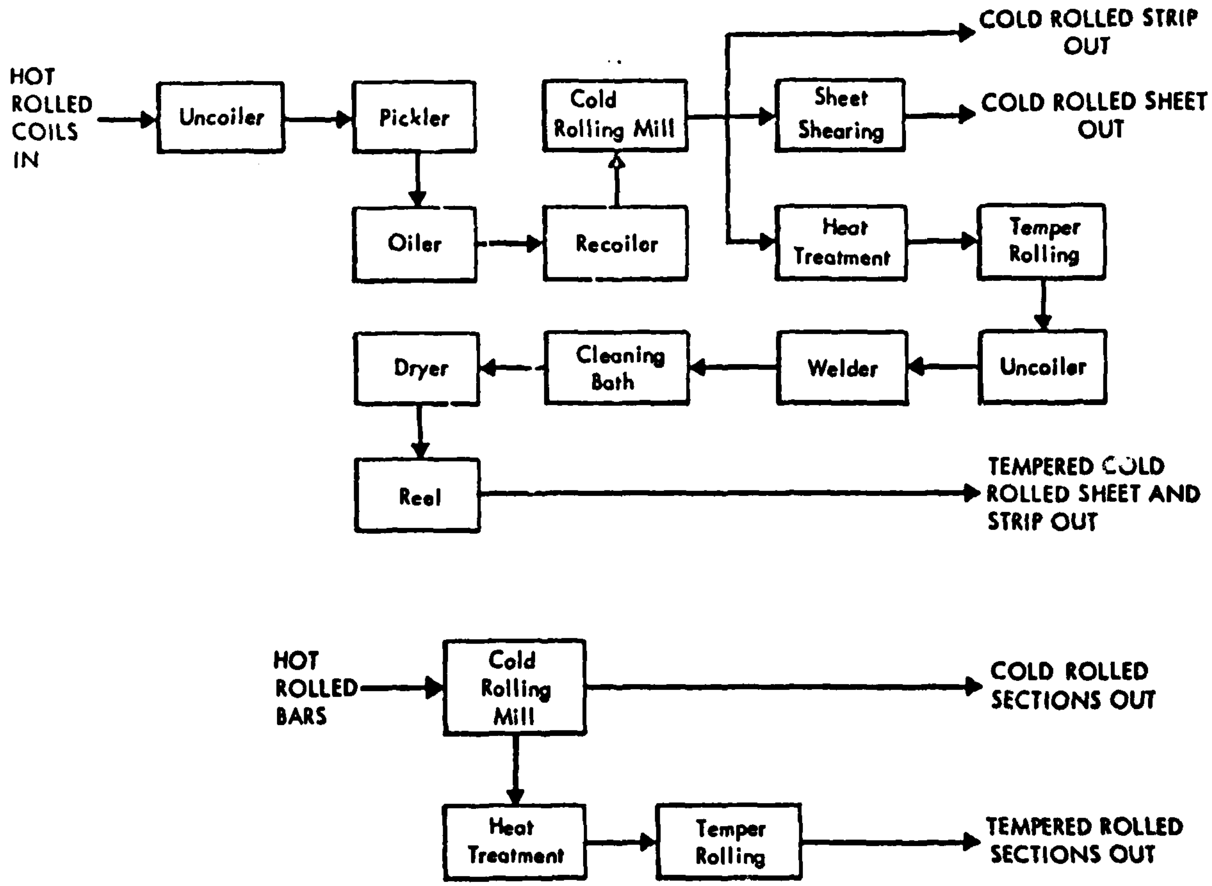
Blast Furnaces, Steel Works, and Rolling Mills Manufacturing Flow Chart



Industry Code 3312

Table 9

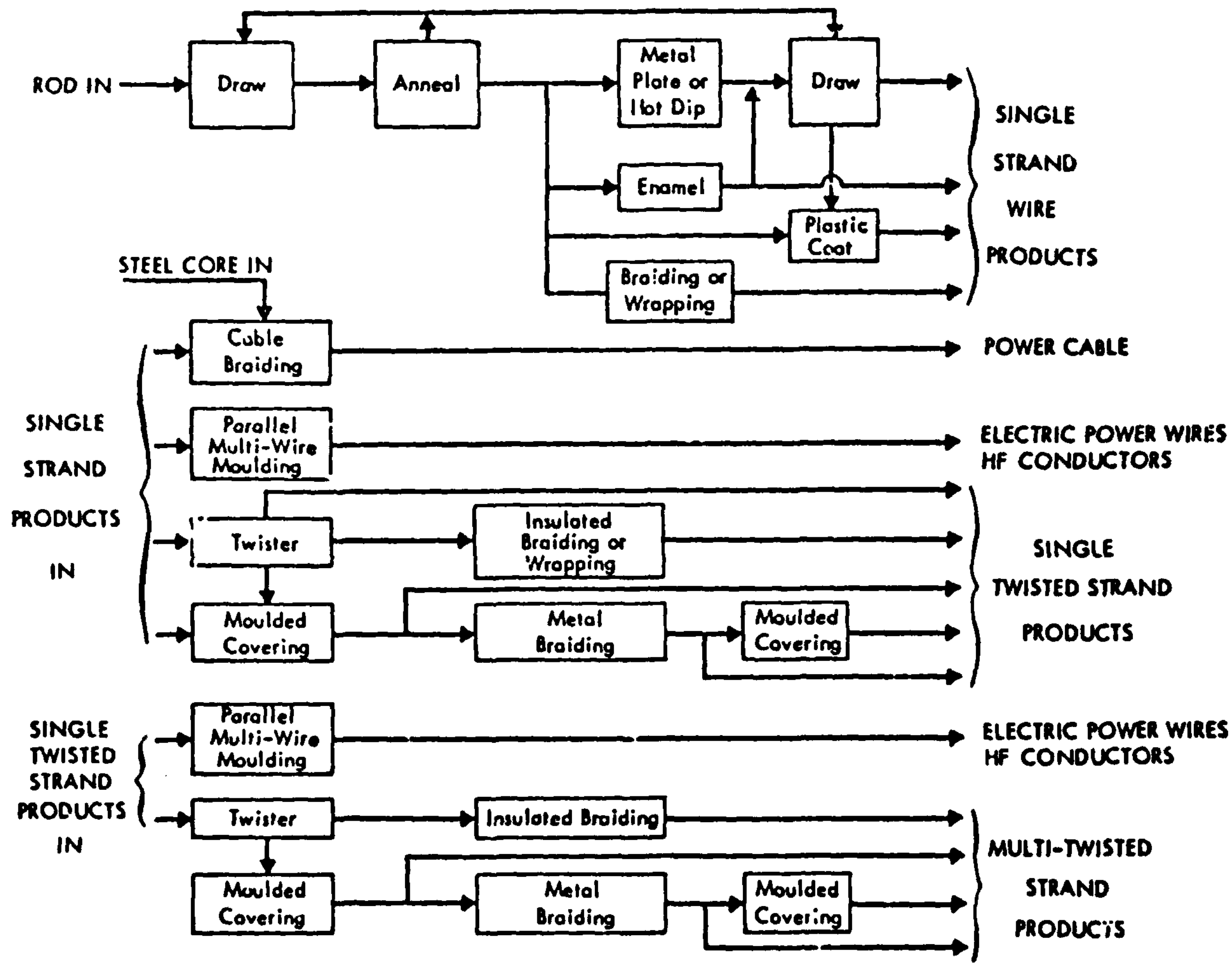
Cold Rolled Steel Sheet, Strip, and Bars Manufacturing Flow Chart



Industry Code 3316

Table 10

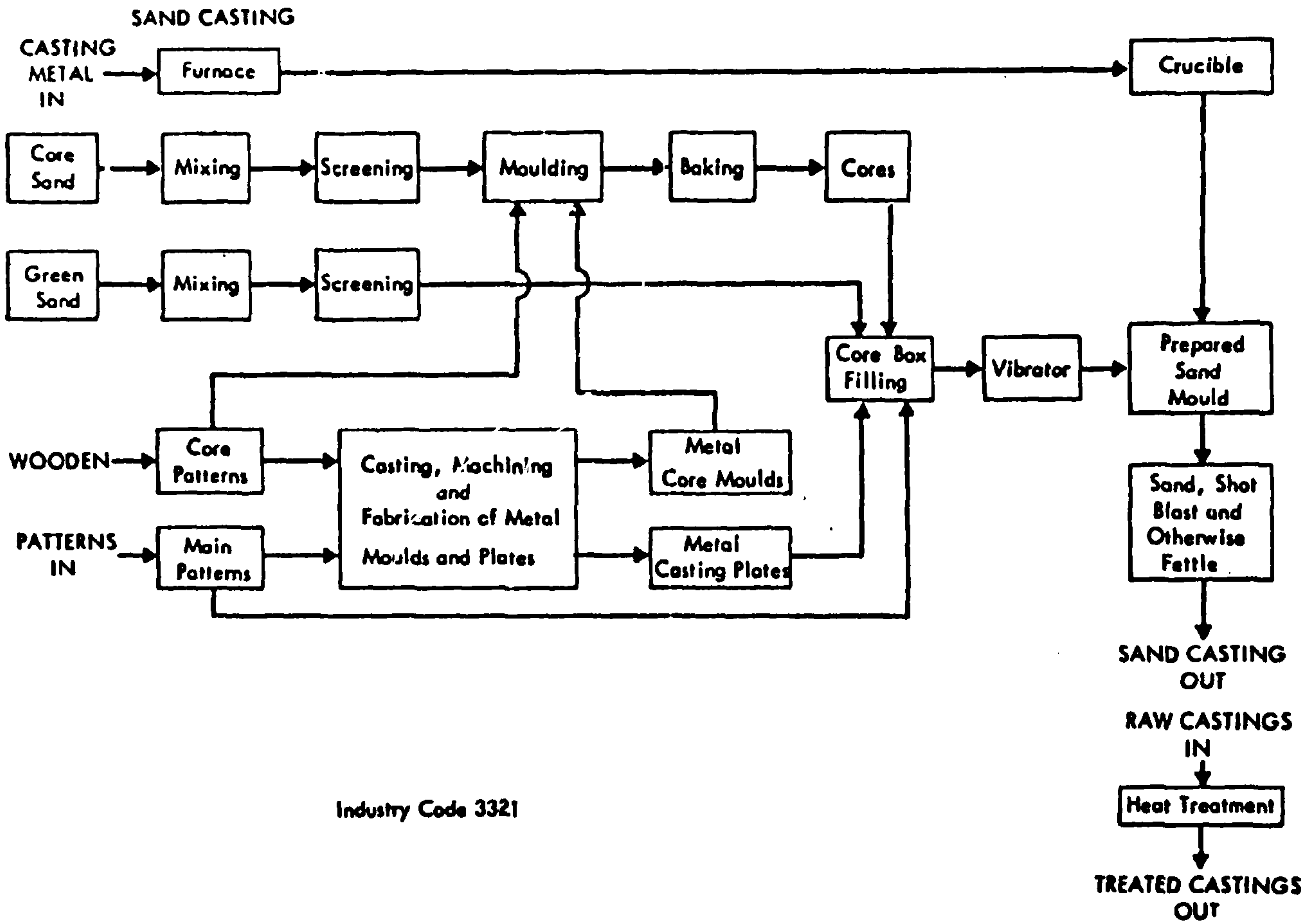
Drawing and Insulating of Nonferrous Wire Process Flow Chart



Industry Code 3357

Table 11

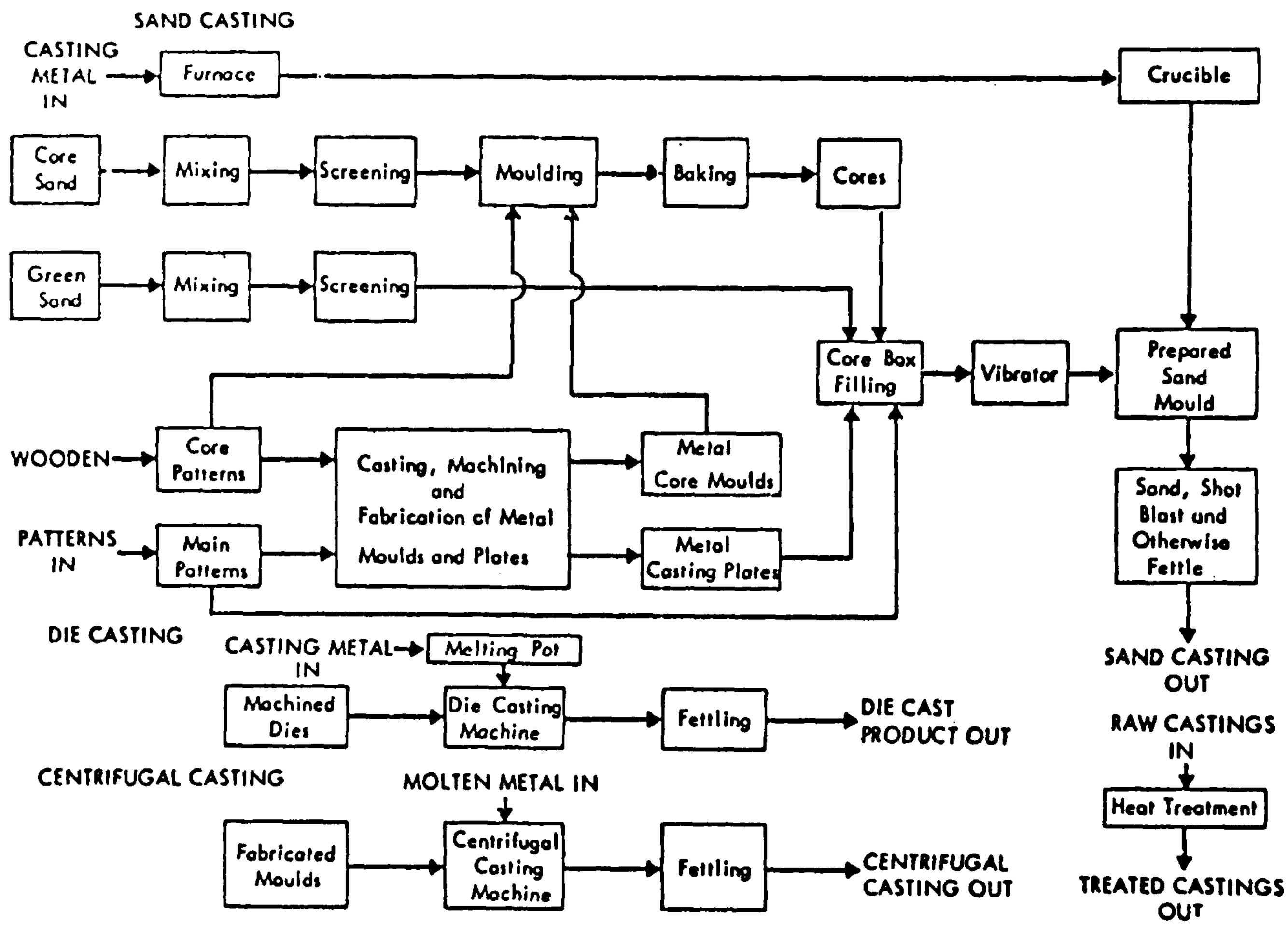
Gray Iron Foundries Manufacturing Flow Chart



Industry Code 3321

Table 12

Aluminum Foundries Manufacturing Flow Chart



Industry Code 3361

Section 8

INDUSTRIAL PROFILES/RAPPORT/MUTUAL AID

For industrial emergency preparedness to be effective, it must be in place in a large portion of industry at the time it is needed — or it must be organized so that it can be implemented rapidly after a warning is issued and before the disaster occurs. Developing a generalized plan such as the industrial protection guidelines (Ref. 1) is just the first step. The second step is to make industries aware of the existence of guidelines, with the corresponding objective of getting them interested in applying them.

> As part of the PIC program, an intensive four-day course in protection of industrial capability against nuclear attack is being given periodically at Emmitsburg through the FEMA training center using Ref. 11.

This approach should be an excellent means of expanding awareness and interest at the industry level.

At the third step, planning must then be carried out at the level of the individual industrial facilities, **and the planning implemented as a preparedness program.** (Some kind of follow-up program would be invaluable here to evaluate the effectiveness of both the information transfer and the implementation programs.)

> A second phase of the Emmitsburg PIC program involves a return engagement to discuss accomplishments at each facility.

Because established programs sometimes falter, another important facet is to ensure the implemented program does not atrophy with disuse. This can be accomplished by the strategy of integrating it with the preparation for general emergencies and everyday exigencies so as to exercise as much of the program as possible on a regular basis.

The role of the Industrial Profile is to provide industries with valuable site specific overviews of their facility's vulnerabilities (originally just to nuclear attack, but more recently to other disasters and emergencies as well); and practical countermeasures are provided as part of it. The strategy behind this is that profile development can serve two purposes: it can be the means (because of immediate benefits delivered) to attract industries' interest and attention, initially, and it can be a means to supply onsite consulting in implementing plans that are developed so that a stronger more coordinated program results.

In its broadest terms, rapport development with industry enables government to obtain the cooperation of industries in order to: maintain the capability to test emergency preparedness concepts among differing types of industry, evaluate practical aspects of industrial hardening, and provide input to industry disaster planning. As part of the program, FEMA/contractor/industry rapport has been developed through contractor participation in a local mutual aid group, the Industrial Emergency Council (IEC), comprising a coalition of industry, city, county, and State organizations interested in a safer environment in their community.

To facilitate industrial involvement, SSI conceived an emergency preparedness clinic, sponsored by SSI/IEC, which would enable 20 to 40 industrial participants to identify their facilities' major vulnerabilities as well as some practical countermeasures. The clinic was based on participants developing an initial plant overview by applying information in an industrial profile development kit (called a Hazards Planning Manual). Included were emergency planning factsheets on floods, power outages, earthquakes, hazardous materials, and nuclear attack. The factsheets, mailed to participants in advance, provided them with condensed background information on each hazard and served to prepare the concerned end-user for the detailed step-by-step worksheets (see examples on floods and power outage in Appendix A) used at the clinic to assess his plant hazard and develop countermeasures.

The clinic was conceived as the ultimate industrial overview and emergency planning generator, because it enabled direct consulting services of nine technical professionals to be provided to the participants. At the prototype session, the

relevant hazards for the region were the five mentioned above, plus fires, structural distress, and soil failures. Emphasis was on practical application (thus the word "clinic" rather than seminar). Participants were provided with information that related directly to their own facilities (for example, all pertinent maps of the local flood plains were provided). Feedback on the usefulness of the information to participants was an integral part of the project in order to enable subsequent improvements to be made.

At the clinic, introductory talks on each hazard were limited to one-half hour, with emphasis on how to apply the material in the Hazards Planning Manual (or industrial emergency planning kit). Small group sessions afterward facilitated direct access to information and consultant expertise, drawing upon the structured sequence of steps in the Manual. Using floods as an example, the basic background would be found on the factsheet on floods sent to each participant ahead of time. At the clinic, the brief half-hour talk covered the typical flood hazards of the local region, a video tape was presented of past pertinent flood disasters and described some effective mutual aid warning systems and preparedness countermeasures, and in the small group sessions, the specific flood hazard analyses were conducted by facility location in detail. Maps indicating flood hazard and covering the entire region were made available, and advice of technical professionals in the subject was given on how to interpret contours, symbols, etc. Questions covered included what 100- and 500-year floods mean, how to find out the elevation of one's facility relative to the elevation of flood waters indicated on maps, whether sandbagging, pumping, or other mitigation measures might be useful, etc.

Three-fourths of the respondents thought the manual "good" to "excellent," and likewise the clinic. (Some of the manual content will be applied in the future to update the industrial preparedness guidelines, Ref. 1.) The clinic approach to industrial emergency preparedness appears very promising; the cost per attendee to conduct the clinic was about $200. This does not take into account any preparation or scheduling costs, but just for the logistic support and the nine professionals and two support persons on the day of the clinic. The cost per attendee would be less for a larger group, but a clinic would become much less effective if the number exceeded around 40 individuals — where the cost per attendee would be about $100

to break even on a repeat session in the same local area. (In preparing for another region, additional costs would be incurred to obtain appropriate flood maps, etc.)

Since the November clinic, two Bay Area organizations have expressed interest in developing or conducting additional sessions of the emergency preparedness clinic, under joint sponsorship, in which case the scheduling and preparatory work would be done by another organization than SSI. The two agencies are the Peninsula Industry and Business Association (PIBA), and the combined San Mateo and San Francisco County Safety Councils.

Section 9

PICTORIAL DOCUMENTATION

As reported in Ref. 4, this part of the program effort is intended to develop material that could influence industries to initiate emergency preparedness programs in general, and nuclear attack preparedness in particular. Elements of this task include public relations, marketing, and training and educational materials. Public relations materials encompass those that contribute to better rapport between government and industry, that provide recognition to industries that develop integrated emergency management and participate in mutual aid programs to the betterment of the local community, and that present a clearer picture of survival possibilities in disaster environments when appropriate preparedness actions are implemented. Under this latter item of public relations, there is some overlap with marketing. Marketing encompasses essentially anything that would motivate industries to consider the subject of disaster preparedness seriously enough to place the subject permanently into company policy. Training and educational materials might also be complementary to the other two elements, as a means to achieve the necessary level of understanding, but would be principally oriented towards documentation of emergency preparedness methods.

SSI has counted among pictorial documentation mechanisms virtually anything that provides visual summaries in some kind of brief or easy to assimilate form. These include videotapes, pictures and slides, movies, data sheets, newsletters. All of these have been applied to the task elements identified above.

The major pictorial means that SSI has developed and used to establish rapport with industry has been via the regular production of a quarterly newsletter for the local government/industry mutual aid group, SCIEC. (Reflecting the broader geographic area represented by its membership, the group has recently shortened its name to the Industrial Emergency Council.) Two recent editions included articles based on material in the all-hazards planning manual (see example in Appendix A)

developed for the clinic, and SSI intends to continue to blend the training and educational aspects with this principally public relations vehicle. With each issue of the newsletter, a data or factsheet has been enclosed (e.g., see Ref. 4, and the two most recent issues of the newsletter and accompanying factsheets included at the end of this section). The factsheets provide handy one-page summaries of vulnerability assessments and countermeasures for one type of disaster.

Pictorial documentation of field and laboratory experiments related to nuclear attack preparedness has continued with a view to providing visual aids for training and education in industrial hardening and shelter upgrading (Refs. 1 and 12); when similar experiments are initiated in the shock tunnel facility (Ref. 13), it may become possible for SSI to control **both** the experimentation and the photography so that staged segments might be captured on videotape and/or film to depict specific aspects that are key to some of industry's (and the general public's) concerns. Particularly valuable to marketing nuclear attack preparedness would be some high speed movies showing, simultaneously, a shored shelter space surviving a blast wave while unhardened space overhead is demolished; the simple expedient of using a transparent lucite floor between the two regions would provide a thoroughly convincing demonstration that survival is indeed possible with appropriate preparation.

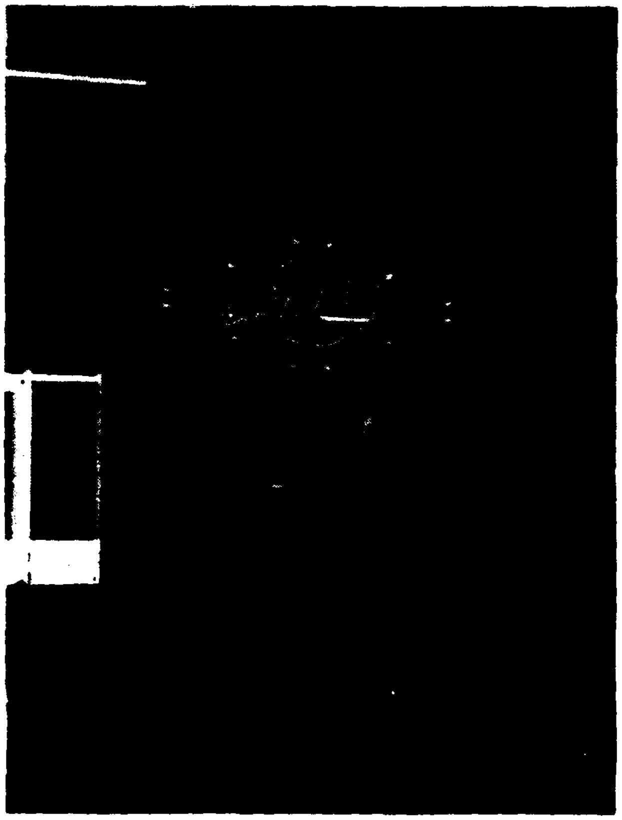
SSI (and IEC) continues to acquire videotapes of real and staged emergencies. These will be used in production of documentaries oriented towards public relations and marketing aspects of general emergency preparedness. Some of the excellent taped real emergencies are owned and copyrighted by TV stations, and SSI/IEC is attempting to obtain releases for their use. The first assembled tape, covering an entire IEC disaster exercise involving a toxic materials spill, was presented (without sound track but with oral commentary) at an Emmitsburg training session, and copies with audio commentary will be made available to FEMA and the Emmitsburg training group in the near future.

THE INDUSTRY AND FIRE SERVICE

TIE LINE

Volume 4 Edition 3 A Quarterly Publication of the South County Industrial Emergency Council 4th Quarter 1982

FIRST HAZMAT TRAINING CONTRIBUTIONS RECEIVED



Liquid Carbonic Corporation and Duolite International recently made separate donations to SCIEC amounting to $1500 to support the development of an in-plant hazardous materials training program within the community. The training course is specifically designed for industrial employees who are involved with hazardous materials or wastes eight hours per day.

Currently an appropriate curriculum for the course is being developed. Probable topics that will be covered include response to hazardous materials emergencies, spill management, hazardous material storage, regulations, shipping, labeling of hazardous wastes, respiratory equipment usage, and many others.

photos: John Paine, left photo, Operations Manager at Liquid Carbonic, and Craig Barney, right photo, an environmental engineer at Duolite International each present SCIEC's director, Jim O'Donnell, with money donated to develop an industrial hazardous materials training program.

TRAINING (CONTINUED FROM P. 1)

The course will last for 36 weeks; the first session is scheduled to begin next February. Raychem Corporation in Menlo Park is to be the site of the pilot program for training. Approximately fifteen Raychem employees are signed up to participate in the course and ten more technicians who are in contact with hazardous materials eight hours a day are needed to fill the quota necessary to implement the first session.

> A few people have worked very hard to get this plan established. If just ten of our members will commit one person to the program, we can get it underway. If we can't get your support, then we may lose the state funding critical to this project and the ability to ever again get anyone's attention at the state level to support SCIEC programs. So give us a call, please. We need this lined up before Christmas.

This program is primarily funded out of state funds, with no charge to participating industries—except that to qualify for state support, the employees' salaries must be paid while at the course (four hours per week). This does not mean that we don't need some more contributions to make this training program concept functional. Though government agencies will supply the main sources of funding for this training program, we need to develop the initial curriculum. Our target for this is another four to five thousand dollars if we are to provide an adequate educational program for hazardous materials handlers. The program must provide a higher level of training in safe hazardous materials practices—particularly when ignorance or carelessness can lead to serious consequences.

As of now, there are no state or local **complete** training programs for industrial employees. Industries must pursue a training system for their hazardous material technicians because they are required to by various regulations of EPA, RCRA, and OSHA. Mark Green, an environmental engineer at Raychem Corporation who is very involved with the implementation of this program, has this to say, "In the past, Raychem has utilized consultants to come in and offer a one day course on safe practices to our employees who handle hazardous wastes. I haven't felt that this information was adequate. It just wasn't enough time spent in such an important area. For that reason, I tried to find additional training through other sources. In this search, I came across SCIEC, of which Raychem is a member, who, working with Scientific Service, Inc. and the College of San Mateo, has developed a training program proposal to instruct people within industry much more extensively than what is offered by any consultant."

This program is one part of a three-phase plan involving: 1) hazardous materials response (vehicles for emergency response and containment), 2) training in safe practices (this program), and 3) resources (emergency services personnel). Training for hazardous materials handlers is currently the high priority.

The training program should be self-sufficient by 1985.

An outline of the curriculum is available. For those interested, call Gretchen Smith at 368-2931. If you come up with something your firm needs that is not included in the curriculum outline, let us know and we'll try to incorporate it within the program.

THE CASE OF THE CONCEALED ODOR

On November 11, South County fire officials responded to a report of noxious fumes located somewhere in the Harbor Industrial area of Belmont. After one and one-half hours of searching around the intersection of Quarry and Industrial Rd. for the source of the odor, the leak was found. A drum of ethyl acrylate had tipped over onto a hand truck and a leak developed. The apparent cause of the accident was that the container wasn't properly strapped inside the truck (a too frequent cause of spills). The effect of saving a few minutes by not tieing down the load was to block the streets for a couple of hours and evacuate several of the surrounding buildings, as firemen worked to seal the leak.

Approximately fifteen gallons of the highly explosive chemical spilled. The firefighters exercised extreme caution while cleaning up the spill because ethyl acrylate is also very caustic. They plugged the leak using ductape and placed it in a containment drum. No one reported any ill effects from exposure to the fumes.

Photo (right): The Culprit.

(Photo credit: G. Robert Gifford (415) 856-6555.)

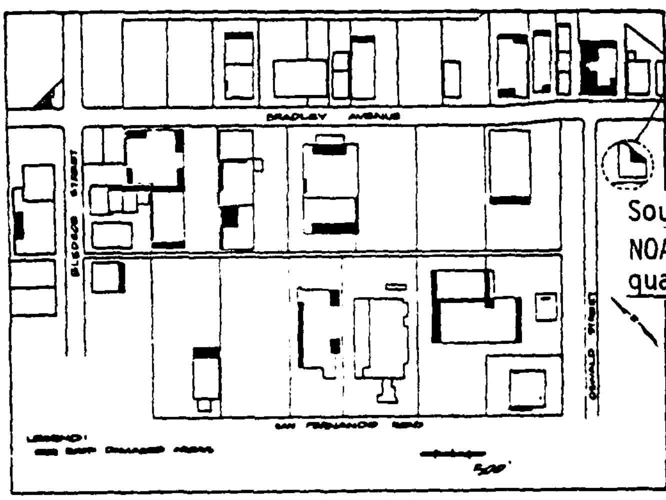
EXPERT ASPECTS

This column, which will appear in each of the following issues of the **Tie Line**, features practical information on emergency preparedness written by a guest author. In this quarter's column, Bob Reitherman discusses a structural consideration for earthquake damage resistance. Bob is an earthquake specialist at Scientific Service, Inc. in Redwood City.

TILT—DOWNS

This brief article will summarize one of the more common factors that will account for much of the damage to be suffered by Bay Area businesses in the next large earthquake. This seismic weakness will account for light industrial and commercial building collapses with an earthquake either on the notorious San Andreas, similar to 1906 (Federal Emergency Management Agency fatality prediction: 11,000 people, and $38 billion in property damage), or on the East Bay's Hayward Fault (8,000 lives may be lost and an even greater property loss of $44 billion).

The "tilt-down." A "tilt-down" is earthquake engineering slang for a tilt-up (a concrete walled building constructed by pouring the walls flat, then tilting them up), which has the particular kind of weakness that may lead to separation of the walls and the roof leading to the collapse of the roof and the "tilt down" of the walls. The tilt-up process itself is not the problem, and buildings built of concrete block stacked in place can be just as vulnerable. The vulnerability lies in the weakness of the connection of the wood roof to the concrete or masonry walls, which proves to be the weak link when the ground shakes. Foundation settlement, splitting of wood roof framing, or other problems can also be serious.



Source:
NOAA report San Fernando, California Earthquake of February 9, 1971, 1973, Volume 1.

The diagram above shows the portions of roofs that collapsed in just one industrial park in the 1971 San Fernando earthquake in southern California. All collapses occurred in buildings without joist anchors, and no building with joist anchors suffered major damage, which raises the obvious question: What is a joist anchor and how do I know if my building has this desirable seismic feature? The diagram on the right answers this question as concisely as possible, and by looking at the exposed underside of a roof (perhaps by removing a few hung ceiling tiles) a non-engineer may be able to spot its presence or absence. The services of a civil or structural engineer would be required to review the overall structure to estimate its earthquake resistance, but this simple "self-diagnostic" advice may be helpful as an initial step.

SCIEC NOTES

Is there anybody out there?!?
After a year of writing, editing and publishing the **Tie Line**, the editor has received very little feedback, written or oral, from any of its members. This is **your** newsletter, and the impact of this type of media can be great. Let us work for you by responding to your input. Who's reading this anyway? Please let us know who you are and what you think of this newsletter—which articles you like and what you would like to see more of.

A committee met November 29 to discuss SCIEC's seminar and drill for next May. The committee consists of Kent Paxton, Tim McHenry, Don Cheu, Earl Helman, Mark Green, Fred Scibuola, and Jim O'Donnell. Your responses to the questionnaire on the subject for the 1983 emergency preparedness seminar and exercise are being tabulated. (Thanks to those who answered—we need more like you!) The results of the meeting will be published in next quarter's **Tie Line**. Direct any suggestions to any of the committee members.

The Federal Emergency Management Agency invited SCIEC representatives to attend the Industrial Protection Emergency Planning Workshop at the National Emergency Training Center, Emmitsburg, MD. The purpose of this workshop was to assist in the development of a planning guide for industry/business protection from all hazards, including nuclear threats. SCIEC attendees were, Lawrence Cabral - FMC, Earl W. Hahn - Sequoia Hospital, Carl Neill - Quantic Industries, Marvin Ross - IBM, and Frank Terranova - Jefferson Union High School. Chuck Wilton, president of Scientific Service, also attended as technical advisor to the FEMA staff.

An SCIEC PR video tape is currently in the making under the direction of Eureka Federal Savings. Eureka has kindly offered the use of their audiovisual facilities and the time of several of their employees. The 30 minute tape will cover SCIEC functions, members, programs, and services.

JOIST ANCHOR

PROFILE: SEQUOIA & KAISER

This quarter's "Profile" focuses on ways that the medical community should be involved with disaster planning and hazardous materials. Interviewed below are two active SCIEC member representatives, Earl Hahn and Don Cheu. Earl Hahn is the Safety and Security Manager at Sequoia Hospital. His responsibilities include emergency response training. Dr. Donald Cheu, the SCIEC liaison from Kaiser Foundation Hospital, So. San Francisco, is extensively involved in emergency medical care response and disaster planning.

EARL HAHN

Tie Line: Why are you involved in SCIEC?
Earl Hahn: I represent Sequoia Hospital mainly for the safety issues brought up in SCIEC. Sequoia holds two disaster drills per year. The help we've received from SCIEC involving various aspects of these drills, such as communications and ambulance runs, is tremendous. We also depend on the liaisons with the fire and police departments. Through SCIEC we can exchange ideas between all jurisdictions.

T.L.: What preparations are made at Sequoia for disaster response?
E.H.: For one, when SCIEC has a drill, we participate in it fully. Our staff is thoroughly prepared because of our constant training. Each person knows his or her specific role in response to a disaster situation; for example, making ready the wheelchairs, bringing down the guernies, calling doctors through the emergency paging system. Also, we have a Disaster Committee at the hospital. Through this committee we plan the entire staff's response to medical emergencies and devise new training activities. SCIEC is helpful when considering different aspects regarding fire preparedness, hazardous materials problems and general safety awareness. Whether it be an "outside" disaster or an "internal" disaster throughout the hospital, everyone here is aware of what part they're supposed to play in response to an emergency.

T.L.: What are the difficult problems you would encounter during internal and external emergencies?
E.H.: Communication deficiencies are the big problem in responding effectively to disasters that happen in the community. In the event of a major emergency, there may be no way to know how many doctors might be able to respond and this would affect everything else we might do. Inside the hospital, communications is less a problem because we have two-way radios so that our security people can branch out into the hospital.

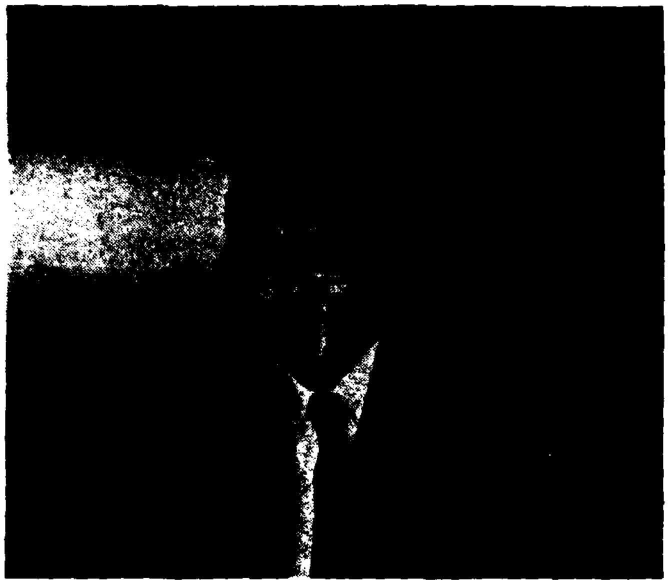
T.L.: How does the hospital handle hazardous material victims?
E.H.: The hazardous materials concern is a fairly new one. On our staff of doctors and laboratory personnel we have people who are aware of the complex problems of dangerous chemical spills. As long as we get complete and accurate reports from the ambulance attendants on what type of hazardous material we're dealing with, our medical staff can help the victim.

T.L.: Discuss Sequoia's involvement in SCIEC's training drill last June.
E.H.: The drill went well except for communication problems. There was a delay of about half an hour before we realized what size of a problem we were dealing with. But when the victims arrived at the hospital our staff responded well. Our major problem was that we were not informed what type of chemicals were involved.

T.L.: Then this is something you'd like to see improved during next year's drill?
E.H.: Yes. There is a definite need for the ambulance drivers to be informed on what chemicals are involved at "the scene". What we really need is some sort of generalized list of which information should be gathered during the spill and to whom it should be dispatched. Ambulance attendants need to relay the information on the contaminating chemicals to the medical staff; they were the ones at the disaster scene, not us. All agencies involved in responding to hazardous materials spills have the responsibility of being properly trained.

T.L.: What are some advantages to the members of mutual aid groups such as SCIEC?
E.H.: The SCIEC contacts I have made have been very helpful. I can help them by giving them the medical point of view, which is important in industrial safety. I depend on them to relay the message of the problems we have here at the hospital to help us work together to solve them. We very much need mutual aid groups to solve some of the information exchange problems—and to expand our ability to deal with truly large disasters—like maybe a major earthquake, but especially when it comes to nuclear attacks. We just don't know enough about what kind of things we're dealing with or might deal with. We have to protect the people who are administering aid to the wounded and contaminated without risk to those doing the administering. They can't be protected unless they have the right garments to wear and instruments to use.

T.L.: Is your next step in emergency preparedness going to cover a nuclear emergency?
E.H.: I am definitely going to take steps to add nuclear preparedness to our current emergency preparedness plan.



DONALD CHEU, M.D., F.A.C.S

Tie Line: Why are you a member of SCIEC?
Don Cheu: Because I represent the San Mateo County Medical Society on projects dealing with hazardous materials where there may be a need for a medical response.

T.L.: What services do you offer industry in the way of industrial emergency preparedness?
D.C.: Well, I'm chairman of the county's Emergency Medical Care Committee so I work very closely with paramedics and the disaster planning of the county. I assist industries by helping to coordinate disaster/multi-casualty incident plans.

T.L.: From the medical perspective, what are some problems with disaster planning?
D.C.: In multi-casualty planning there is a lack of coordination in the dispersion of patients to hospitals. Disaster patients should not all go to one hospital because it delays treatment. Another problem is the large turnover rate of paramedics in the past few years. It's hard to keep everyone trained. These are some of the reasons why I respond to emergency incidents and try to help to coordinate them.

T.L.: How should the medical community be involved with hazardous materials?
D.C.: First of all, the medical community needs to be better informed on what the effects of different hazardous materials are on people. In some cases if the wrong treatment is given, the result is more harmful than helpful. Immediately accessible data for specific chemicals is necessary for the handling of hazardous material victims.

T.L.: Then isn't hazardous material training necessary for the medical community?
D.C.: Because the incidents are so infrequent, it is difficult to train the medical community and have them retain the data. I think we need a data bank and that's where I'd like to see SCIEC come in. The Council could form a data bank at any one of the hospitals and arrange it like a poison control center, only it would be a toxic control center. Another thought is that the poison control center in San Francisco could take over the responsibility of toxic material information.

T.L.: Does Kaiser run any training drills for large-scale emergencies?
D.C.: We are required to have two drills per year for accreditation. We just had a radiation spill drill within our facility from which we learned alot.

T.L.: How did it go?
D.C.: It didn't go well at all, but that's how you learn. If it went too well then either the scenario was too programmed or else the exercise did not really fully test the disaster plan. In addition, this was our first exercise dealing with a radiation spill.

T.L.: It seems that you were rather disappointed with several aspects of the SCIEC disaster drill last June...
D.C.: After twelve years of participating in disaster drills, I still see the same mistakes! Keying in on the medical aspects of this drill, it was the worst I have ever seen. Groups of victims weren't removed out of the danger zones, there was no coordination between the medical and fire workers, Red Cross representatives were told to go stand in the corner someplace, and I think these situations are just rotten! The real occurrence is going to be more hectic than any drill and if you don't follow the rules in the drill then you're going to have a tough time during the real thing.

T.L.: Suggestions for next year's drill?
D.C.: We need a great deal of pretraining.

T.L.: What directions would you like to see SCIEC go in?
D.C.: I'd like to see SCIEC organize a data bank of all the chemicals and toxic materials used in area industries listed along with the medical symtoms and treatments, clean-up procedures and other necessary information. I realize that alot of industries don't wish to publicize what toxic materials they use because of competion and community reaction, so they could make a "plain paper" donation—a listing of their on-site chemicals on a piece of paper which doesn't say who has it or where it comes from. That way we will be aware that the chemicals exist in this area. The medical community needs the information if it is to rapidly respond to the needs of victims exposed to any hazardous material.

ATMOSPHERIC ASPECTS OF HAZARDOUS SPILLS:

THE INVISIBLE THREAT

by Walter F. Dabberdt, Ph.D.

The following article contains excerpts from a manuscript with the same title. To obtain the complete manuscript, write the author at: Atmospheric Science Center, SRI International, Menlo Park, California 94025.

The release of hazardous or toxic substances into the air presents a unique challenge to fire and police personnel and other first and subsequent responders. The toxic cloud frequently is invisible to the eye and its direction, spread, and rate of movement are extremely difficult to judge without special equipment and expertise in micrometeorology, atmospheric chemistry, and dispersion theory. Nevertheless, with some training and the right hardware, weather information, and dispersion algorithm, timely and informed decisions can be made that will save lives and effectively utilize available personnel and resources. Moreover, pre-planning can significantly assist responders by providing valuable information **before** an incident by facilitating optimization of the location of storage facilities to minimize the hazard to employees, safety workers, and the general public.

Proper resources and training can enable safety personnel to make timely and reliable estimates of the position, movement, and danger of toxic clouds. To do so, they must first measure or estimate the nature and rate of release of the toxic substances, and the movement and spread of the toxic cloud in response to wind conditions, atmospheric structure, and topography. Next, they must process this information to produce meaningful indices of the severity of the problem. Information ultimately required includes:

__What is the extent and shape of the "lethal" zone in which people are apt to be killed or badly injured?

__And "serious" and "noxious" zones in which people can be injured and inconvenienced?

__How will conditions change with time?

The answers to these questions depend on what chemicals are entering the air (either directly or as a result of reactions among various chemicals or with water), how fast the toxic cloud front moves and how broad it is, and the rate or nature of the toxic release and how it changes with the duration of the release. Nearly all these factors depend, in turn, on weather conditions and how they change over the total period of release.

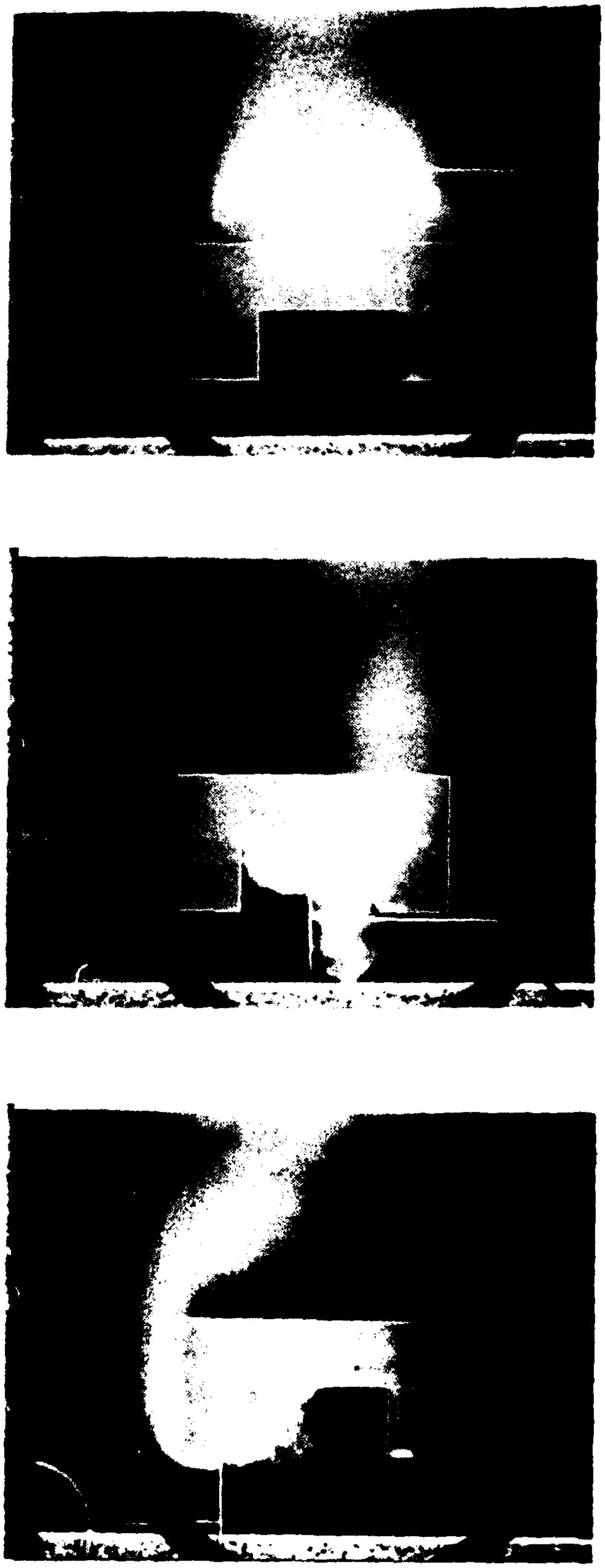
With detailed and accurate inventories of chemicals stored in or transported through an area, the consequences of a range of accident types can be evaluated ahead of time rather than under the pressures of an actual event. The release data base should consider the form in which the chemicals are likely to enter the atmosphere based on realistic accident scenarios. For example, gases may be released directly, through vaporization, or as the result of the chemical reaction of other, non-gaseous compounds. And, it is important to remember that not all atmospheric hazards result from gases; solid or liquid matter can remain suspended in the air if they are small enough.

A valuable resource available for pre-incident planning is the physical simulation of various accident scenarios that can be done in an environmental wind tunnel. With information of this kind, industry can develop effective emergency response plans for their employees and for use by incident responders. Wind tunnel tests can assess the suitability of alternate chemical storage locations by evaluating the build-up of atmosheric concentrations of toxic substances from potential spills and the corresponding hazard to workers. These tests can also identify locations where dangerous recirculation patterns will **not** develop, thereby optimizing the location of fresh air intake vents and identifying vents requiring immediate closure in the event of an incident. Furthermore, the information on the effect of buildings on the initial diffusion of the cloud can be used to refine calculations of danger zones farther downwind.

Some examples of an actual wind tunnel test are shown in the accompanying photographs, taken during a recent study conducted jointly by SRI and ESSCO* at the latter's fluid modeling facility. In all three photos, the wind is flowing from bottom to top and the view is from above. In the upper photo, the spill is occurring just downwind of the building, and a large nearly-stationary eddy is causing the spilled material to recirculate and build up behind the building. In the middle photo the spill is taking place in the open part of the "U", which again faces into the wind. Again, there is poor dispersion, although some of the material is escaping over the top of the building from the right corner of the notch. The bottom photo shows the source adjacent to one of the short ends of the building. The dispersion pattern is improved as the extent and density of the material is significantly less than either of the previous two spill locations. By changing the direction of the wind and the height and location of the storage tanks, optimum locations for the tanks and fresh air intakes can be found.

Fortunately, dangerous spills into the atmosphere occur infrequently. But when they do occur, response time is short and the capabilities and expertise necessary to respond effectively are correspondingly greater. Having the necessary resources available and tested **before** an accident is the obvious key to minimizing risks and casualties **during** an incident.

*Environmental Science and Service Corporation, New York.



Wind tunnel simulation of a hazardous spill from different locations adjacent to a "U"-shaped building
(all photos are taken from above the building, and the ambient wind flow is from bottom-to-top of each photo)

SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL

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The "Tie Line" is a quarterly publication of the So[...] County Industrial Emergency Council (SCIEC), a non-pr[...] educational organization dedicated to fostering cooperati[...] between industry and government in the field of emergen[...] preparedness. Letters, articles, and announcements fr[...] readers are welcome. Limited advertising space is availa[...] at $25.00 per quarter page, camera-ready copy.

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☆☆☆☆FINAL WORDS ON THE ABAG PROJECT ☆☆

Thanks be to all SCIEC members who responded to the SCIEC/ABAG survey on hazardous materials training last year. After months of examining the specific training problems and needs of public agencies, private industries, and medical emergency facilities, a comprehensive guideline for a regional hazardous materials educational system is the result.

Five recommendations were made. In brief, these include:

1) Private industries should provide *specialized hazardous* materials training patterned to fit the needs of their specific processes or operations. Four different operational requirements were identified that lead to targeting four employee groups for different levels of training. The groups are as follows:

- -all employees that come into possible contact with hazardous materials
- -shift supervisors, department supervisors, safety managers
- -In-plant emergency response team members
- -Management

2) Public agencies should assign a large portion of their resources to incident prevention education and information activities.

3) Public agencies should train their employees who are responsible for incident prevention in hazardous materials management and control of the use, storage, and/or transportation as part of their professional preparation.

4) Medical response personnel responsible for the transportation, triage, and treatment of victims should receive job-specific hazardous materials incident training.

5) Emergency rooms should be classified as to their ability to handle hazardous materials emergencies.

Association of Bay Area Governments is currently struggling to implement the guidelines into a regional spill plan. Copies of the guidelines are available from ABAG by calling 841-9730.

Erratum Please be advised that the picture on page 5 of last quarter's "Tie Line" is credited to the Oakland Tribune.

EMERGENCY PLANNING FACT SHEET
This issue contains a complimentary Hazardous Materi Fact Sheet from Scientific Service, Inc. Keep these solutio in safe storage.

South County Industrial Emergency Council
South County Fire Station #5
895 Brittan Ave.
San Carlos, CA 94070

SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL
FIRE SERVICES - INDUSTRY

EMERGENCY PLANNING FACT SHEET — INDUSTRIAL

HAZARDOUS MATERIALS

SCIENTIFIC SERVICE, INC. 517 E. BAYSHORE REDWOOD CITY, CA 94063 (415) 368-2931

Contingency Planning Checklist

—Determine approximate level of risk at your facility: hazardous materials onsite indicate highest hazard; nearby rail or highway route indicates moderate hazard even with no onsite hazards.

—Your ideal responding fire department should be given an inventory of hazardous materials, onsite, on a building plan, and procedures for reporting spills should be coordinated with local fire department. See "Preplanning" on the back.

—Type of spill response information and expertise available from manufacturers of materials you have onsite should be determined. The larger chemical manufacturers provide extensive on-call expertise for spill responses involving their products.

—Employees who work with hazardous materials should be informed about the hazards of the substances and what to do if a spill occurs. Material Safety Data Sheets (MSDS) of materials onsite should be committed to memory.

—In-plant fire brigades should not be used to deal with spills unless given extra training. Personnel injury, or counter-productive response (spraying water-reactive materials, for example) could occur.

—Protective equipment to be used by in-plant response teams must be of adequate quality to deal with expected service conditions (breathing apparatus for toxic gases, explosive vapor meters for explosive gases, acid suits for acids, etc.).

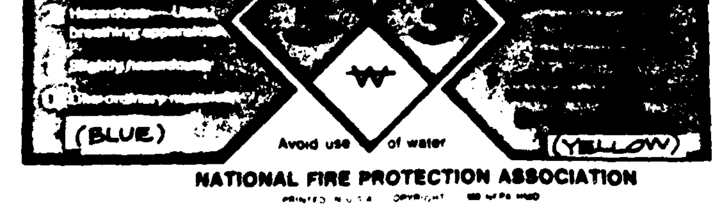
—The plan should include work and home phone numbers for facility officers, response personnel and cleanup service.

—Evacuation procedures should be devised to exit personnel from the site (while fire evacuations usually cover only exiting from a building). Consider various wind directions.

—Hazardous material plans (emergency response teams, evacuation, notification of fire department, etc.) should be tested at least annually.

—First aid and ambulance notification procedures for hazardous materials should include informing the medical personnel of the specific substance involved.

NFPA Hazard ID Labels



This chart available in sticker format from NFPA, Batterymarch Park, Quincy, MA 02269.

Hazmat Liabi[illegible] Insurance

Is your firm covered for the cost of a hazardous material spill cleanup? As part of your firm's emergency preparedness planning, a written statement should be obtained from your insurance company indicating the conditions of coverage for hazardous material disasters and reimbursement for cleanup costs.

Approximately three-quarters of all hazardous material problems are "non-sudden" pollution releases. Coverage for this type of occurrence generally was not available in the past. Because of this, in 1981 the Insurance Services Office (ISO) developed a new form that insurance agencies could use to offer facility operators the environmental impairment liability (EIL) insurance policies for gradual releases. Under this coverage, reimbursement is required if the initial exposure of a third party to a hazardous material release results in eventual injury, or if later manifestation of third-party damage from a release is noticed.

(Source: Hazardous Materials Intelligence Report, August 20, 1982)

Relationship To Other Hazards

Earthquake: Earthquakes can damage tanks, pipes, and equipment, or derail trains or cause traffic accidents, and this damage can lead to spills. In the post-earthquake environment, telephone, electrical, and water service may not be available, so you should be prepared for this.

Fire: Hazardous material incidents are frequently accompanied by fire. Existing fire safety and response programs can be revised and extended to deal with hazardous materials as well, to take into account the unique aspects of hazardous substances.

Flooding: Tanks, even underground ones, can buoy up when flood waters surround them; flood waters surrounding furnaces have led to steam explosions.

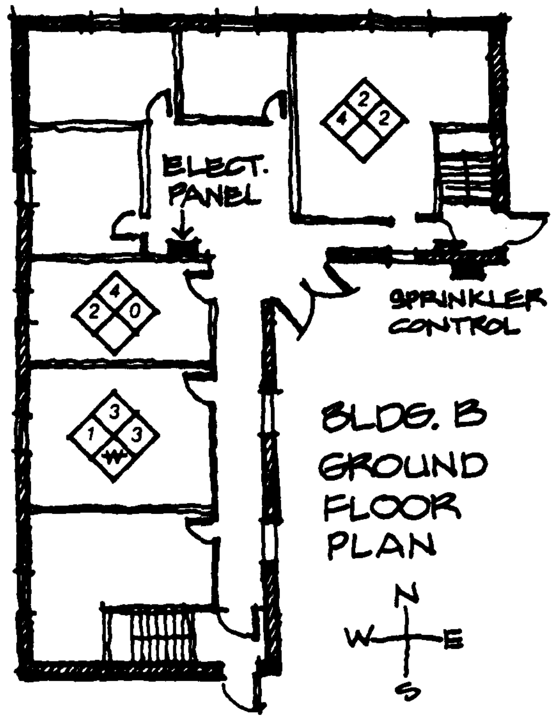
Hurricanes, tornadoes, wind storms: Wind damage can cause pipes or tanks to rupture, releasing hazardous substances.

Power outage: In some industrial processes, electricity is needed to run cooling systems to prevent overheating, to run pumps to supply inhibitor to prevent explosive reactions, or to supply heat to keep hot fluids from solidifying.

Chemtrec: (800) 424-9300

CHEMTREC (Chemical Transportation Emergency Center) is a 24-hour hotline telephone service provided by the Chemical Manufacturers Association. The purpose is to rapidly provide technical information to emergency personnel in dealing with *transportation* spills of hazardous materials. CHEMTREC can provide information on the hazards posed by a particular substance (is it poisonous to breathe? explosive? is it absorbed through the skin? etc.) and suggest the recommended response measures (evacuation distances, neutralizing procedures, whether to spray with water, etc.), based on previously filed data. CHEMTREC can be most helpful when the caller knows the exact chemical involved (usually provided on labels or shipping papers), the manufacturer and shipper involved, and concise facts on the situation at the scene (location of nearby population, presence of fire, etc.). When the substance is unidentified but the rail car or truck identifying number is known, CHEMTREC can conduct a search to identify the chemical involved.

PREPLANNING



Fire service response to fires and other incidents at industrial, institutional, and other commercial facilities can be more effective when firefighters know what to expect at each site in terms of facility layout, hazards, and resources. To help minimize injuries and property loss during a disaster, give your fire department a detailed, up-to-date "preplan" consisting of maps, notes, and a resource list and keep a copy on file.

Following is a general checklist for a preplan. Check with your local fire department first for any additional information or special format that might be useful.

Information Needed

Plot Plan—Map the general layout of the facility, number or label each building or zone, and indicate locations of:
- utility shutoffs, and the consequences of shutoff
- water hydrants and mains
- standpipes
- water and electrical lines
- control valves
- sprinkler areas and connections
- street boxes
- storm drains
- any barriers to access (fences, railroad tracks, etc.)

Floor Plans—For each building or zone show:
- emergency exits
- stairs and elevators
- fire alarms
- special equipment and control panels
- occupancy or activity
- number of employees, their hours, and any physically handicapped
- structural notes (wall and roof construction, ceiling height, firedoors, etc.)
- access routes (vertical openings, fire escapes, etc.)
- name and maximum likely quantity of each hazardous material stored

Resource List—Specify the following:
- the names, titles, and telephone numbers of personnel that should be contacted in case of an incident, either during or after business hours. List an alternate for each contact.
- the type, quantity, and locations of any hazardous material spill abatement materials such as sorbents and neutralizers.

Organization and Format

A useful way to organize your preplan is in a looseleaf binder. Sheets can be easily added or removed. Plastic covers for the sheets will help them last longer. Be sure to include an index in the front.

Updating

Include the date of compilation on your preplan. Keep your preplan up to date. Notify the fire department any time your facility undergoes significant changes, such as new construction, rearrangement of hazardous material storage, changes in key personnel or their telephone numbers, etc.

(Contributors of background information: Redwood City Fire Dept; Litton Industries; South San Francisco Fire Dept.)

For More Information

National Fire Protection Association (NFPA), 470 Atlantic Avenue, Boston, MA 02210; NFPA textbooks, pamphlets, standards, and training materials are standard references in the fire and hazardous materials fields.

Warren Isman and Gene Carlson, Hazardous Materials (Encino, CA: Glencoe Publishing Co., 1980); fire service textbook; other hazardous material books available from the same publisher.

Chemical Manufacturers Association, 1825 Connecticut Ave., NW, Washington, D.C. 20009; technical data on hazardous materials; responsible for the CHEMTREC system.

Bureau of Explosives, Association of American Railroads, 1920 L St., NW, Washington, D.C. 20036; rail-shipped hazardous material information.

Fire marshal or public information office, local fire department: onsite inspections, advance coordination for spill response, referral to local sources of information, services, and products.

Occupational Safety and Health Administration, Technical Data Center, Department of Labor, 200 Constitution Avenue NW, Washington D.C. 20210; safety regulations for workers.

U.S. Coast Guard, Department of Transportation, Washington D.C., 20590; CHRIS is the Coast Guard hazardous material classification system, used for waterway spills.

U.S. Department of Transportation; responsibilities include organization of the hazardous materials programs, effectiveness of the regulatory effort, effectiveness of the compliance and enforcement programs, adequacy of emergency response and training programs.

Environmental Protection Agency, Washington, D.C., 20460 the major enforcer of environmental legislation; creates environmental standards; makes environmental studies.

THE INDUSTRY FIRE SERVICE

TIE LINE

Volume 5 Edition 1 □ A Quarterly Publication of the South County Industrial Emergency Council □ 1st Quarter 1983

LARGEST COMMUNITY SPILL OF 1982

Due to improper installation of underground storage tanks, San Mateo County Transit District repair yard in Belmont was the site of the largest community spill last year. Run-off from heavy October rains ran into the tanks that collect all the waste oil and materials generated in the large Samtrans yard, and the waste floated out the top. Maybe you should check to see if your tanks are susceptible to run-off and take steps to correct faulty conditions to avoid unnecessary expenses.

Approximately 1,000 gallons of waste oil mixed with about 14,000 gallons of water. This mixture flowed into the surrounding streets and storm drains. South County Fire called in the Fish and Game because the oil flowed into a nearby creek and headed towards the Bay. Fish and Game then called in a local waste control company. The waste control company cleaned out the underground tanks completely and all the storm drains in the area. By the time they were through, they had worked for three weeks, had taken up about 15,000 gallons of waste water and 30 yards of dirt, and spent $15,000.

Photos: The left photo shows the condition of the Samtrans repair yard. In the background, just before the buses, is the location of the defective underground storage tanks. The right photo shows the drainage ditch which flows from the underground storage tank area into a nearby creek. This whole area became contaminated with the waste water from the flooded tanks.

HAZARDOUS MATERIALS TRAINING PROGRAM UPDATE

By Mark Green, Environmental Engineer, RAYCHEM CORPORATION

Through Raychem's active participation in the South County Industrial Emergency Council, Raychem has been approached to assist in the development of a hazardous materials training program that will satisfy related training requirements. The ultimate goal of SCIEC is to develop a hazardous materials training program that will benefit all industry and governmental agencies in the Bay Area responsible for hazardous materials management. SCIEC is collaborating with the State Division of Apprenticeship Standards (DAS) and the College of San Mateo (CSM) to design a training program that will follow an apprenticeship format and result in college transferable credits upon successful completion of the program. If designed in this manner, the hazardous materials training program will qualify for funds and other assistance available from the DAS, CSM and other state and federal funding agencies, to allow the training program to be financially self-sufficient in its second year of operation.

Mark Green, SCIEC vice president, hands Craig Barney, SCIEC president, a check for $5,000 from Raychem Corp. for the implementation of the hazardous material training course.

In response to the requests for financial and technical assistance in the development of the curriculum for the course, I have developed a general course outline to be used in having the training program approved and funded by the State. A sample outline is shown below. Raychem has already made a $5,000 donation to SCIEC to be used for its proposed Hazardous Materials Incident Response System for San Mateo County, of which Raychem training is an integral part. **Raychem has recently been accepted by the DAS to sponsor the apprenticeship program in its initial year.** Raychem has also been asked to sponsor the first year of the program and to provide 15 Raychem employees to attend the first offering of the course.

Once the program has been approved by the State and implemented, the public and private sector will be able to enroll students in the training program for the entire training session or any part of it at no cost other than the employee's time. In addition, funds will be forthcoming from the State to provide much needed hazmat response equipment for the county to which fire departments will have access in an emergency. The training program will be the first of its kind in the nation.

Below appears a sample course outline that I developed. It incorporates training which is required by law plus additional training in toxicology, personal protection, emergency treatments, proper chemical storage, labeling, DOT requirements, inspection, and recordkeeping.

MODULE I

a) Basic applied chemistry, hazard criteria

b) Toxicological concepts, routes of entry, systemic toxicology, classes of toxic substances, health standards

c) Recognition and evaluation of hazards, environmental control of hazards, principles of prevention, medical and/or engineering control, personal protection, respiratory equipment

d) Procedures for procurement, storage, distribution of chemicals, for working with chemicals in laboratories, legislative trends

e) Emergency treatments and measures, 1st aid, CPR, triage

MODULE II

a) Chemical spill management, scene isolation, traffic control, containment, notification, environmental hazard monitoring, emergency comman system, spill cleanup, emergency respons equipment, chemical information sources, follow-u reporting

b) Large volume hazardous material storage, berming, separation of incompatibles, storag distances from property lines and/or buildings, monitoring of surface rainwater runoff, are warning signs, security, storage area inspection

c) Inspection log, recordkeeping, hazardous wast quarterly and annual reports, hazardous materia transportation vehicle maintenance and registrati with DHS

d) DOT regulation, proper containerizatio labeling, marking, placarding, shipping paper manifests, incident notification

e) Repackaging, material transfer betwe drums, drum recycling, drum sampling, drum a laboratory bottle cleaning, chemical reuse/reco ery/recycling

f) Procedures for using, inspecting, replaci emergency and monitoring equipment, k parameters for automatic waste feed cut- systems, communication or alarm systems

g) Response to fire or explosions, a groundwater contamination incidents

The rough course outline will be expanded int course curriculum. Input is welcome. We anti pate beginning the training program in early April all goes as planned.

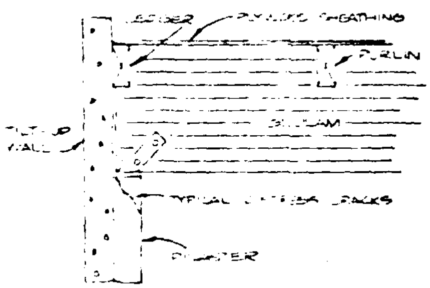
EXPERT ASPECTS

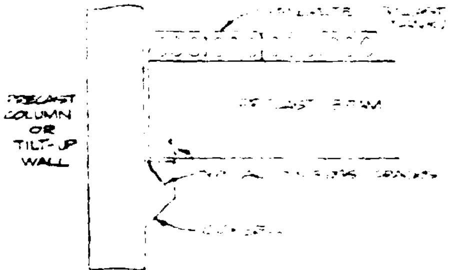
In the following article, Dr. Gabrielsen offers some guidelines for picking out signs of structural distress in common commercial buildings. Dr. Gabrielsen is a civil engineer at Scientific Service, Inc. in Redwood City and Professor of Civil Engineering at San Jose State University. He is an expert on earthquakes, structural dynamics, timber design, and statistical analysis.

STRUCTURAL DISTRESS

One of the common types of commercial buildings found in the local area are buildings of the tilt-up design. These buildings are constructed by concrete with the walls poured on the ground and tilted into position. The walls are then connected by a "closure pour" between the wall segments. These closure pours are often made to act as a support for the beam structure holding up the floors and/or roofs, and are constructed such that they form a pilaster or a simple corbel to set the beams on. The beams are of two common types. One is precast concrete, generally used in conjunction with a *precast flooring* system or roof, such as Spancrete. Another very common type is the glulam purlin-plywood combinations used for both floor and roof construction in these low rise structures. The structures often are used with a portion being set aside as an office area, parts of it being manufacturing and warehousing. Sometimes the roof is used as a parking area (these are the ones that are generally concrete.)

One of the common and dangerous *structural* distress mechanisms exhibited in these buildings is in the area of the pilaster or corbel, i.e. the point where the beam and corbel interface. This point often exhibits distress which can present a danger to the occupants and equipment within the building as shown in the sketches below.





SALUTATIONS FROM YOUR NEW OFFICERS

Greetings and a happy and prosperous New Year to you all. Your new officers recently spent some time knocking heads to come up with our goals for 1983 which we would like to present now. Are you ready?

First and very importantly, we will increase our membership. Our plan to attract new members is to develop and offer assorted new services to our members—and to present our meetings with flair. From now on, you will receive a typed agenda prior to each meeting which will offer such goodies that you won't be able to miss it. We plan guest speakers from diverse backgrounds as an added attraction. Among the assorted new services, SCIEC will offer access to our hazardous materials training program. Also we have proposed a resource library to help out members with varied needs.

Secondly, because of the lively and interesting nature of our activities, we will encourage more participation from our members. The contents of the resource library need defining, and we need input on the cirriculum for the hazmat training program. Assistance with our regular activities such as writing the Tie Line, planning our meetings, and preparing our annual disaster seminar and exercise is essential. Let's hear from you!

One final word on the Tie Line. The more input, the better it will be.

Your officers,
Craig, Mark, Judy, and Gretchen

Four common causes for this type of distress are:

1) Inadequate detailing of the design in the region of the corbel or pilaster
2) Damage to the corbel and/or pilaster during construction (This is most common in the buildings that use heavy precast beams.)
3) Inadequate consideration of thermal stresses in the design and construction of the building
4) Differential settlement between the interior and exterior of a building causing rotation of the walls relative to the vertical position

Of course, the four items above can work in concert and further aggravate the problem. In other words, an inadequate or minimal design combined with an thermal problem can cause extensive damage of this type. The third and fourth items, thermal and settlement induced distress, often occur over a long period of time and may not be observed for several years. Periodic inspection often turns up the sudden appearance of this type of distress. The distress is obvious—often the cause is subtle and requires some professional investigation to determine the cause, and further to determine if the condition is getting worse, is stabilized, or is dangerous.

PROFILE: CALIFORNIA HIGHWAY PATROL

*Community disaster response commands a smooth interaction of numerous agencies within a crisis environment for the outcome to be successful. Educational training drills provide the opportunity for different agencies to rehearse their roles during emergency situations. Below, Lt. William D. S. Kinsey explains to **Tie Line** how the fire and police departments responded to last year's SCIEC disaster drill. Lt. Kinsey is the Field Operations Officer of the CHP in Redwood City.*

Lt. William D.S. Kinsey

Tie Line: In last year's SCIEC disaster exercise at Dalmo Victor, was the CHP the first to receive notice of the accident?
Bill Kinsey: No, and we were not the first ones at the scene. The fire department was the first one to arrive at the accident, but a couple of our officers arrived almost simultaneously so that they got involved in the accident and the incident command post area. The fire department set up the incident command system.

T.L.: How was this done?
B.K.: They designated the commanding officer by the vest he wore. Everyone at the command post had a vest, and if someone's role within the command post area changed, his vest changed right along with his change in repsonsibility. The officer that had become the Incident Commander turned this task over to me upon my arrival. I then put on his vest and spent the rest of the drill as the Incident Commander. I really learned a lot in this role. I had come to the drill only to observe and ended up being zapped into a commanding position.

T.L.: Was this the first time the CHP was given the position of incident commander in the incident command system?
B.K.: No, we had this role during the previous hazardous material drill.

T.L.: How did the CHP interface with role players from other agencies?
B.K.: Well, we tried to enhance the coordination between the police and fire departments by utilizing fire and policemen in alternating roles. For instance, in the case of the law enforcement officer having charge of a special function, we would assign a fireman as his assistant. And vice-versa. In this way, both would clearly understand the workings of each department so that in the end, we would assist in strengthening communications between agencies. In our limited role-playing here it worked quite well.

T.L.: And what about during the real thing?
B.K.: Probably about the same. I think the biggest thing, and I say this over and over, is the fact that when fire and police work together, we are pretty effective. For example, we each know what our roles are, and the fact that somebody becomes the scene coordinator takes that burden off a fire suppression officer. He no longer has to deal with the press, he no longer has to do **anything** *other than* fight the fire. Through coordination with other agencies like medical assis tance, any other kind of activity can be directed to somebody else to handle, so that each individual can fulfill his role properly—whether it be a real emergency or a drill.

T.L.: Looking back, what were some strengths and weaknesses of the overall response to the emergency?
B.K.: First let me say that the entire incident system worked very well. Our interaction with all the other agencies—the Coast Guard, the EPA, the San Mateo County Road Department, et cetera—went smoothly. To be quite honest with you, the drill was intended to be a learning experience for all the people involved. I think it went reasonably well and was reasonably realistic—as much as could be expected.

Of course, some mistakes were made—that's what drills are all about. Some of our mistakes were human mistakes; others were due to a lack of proper equipment. For example, the command post was much too close to the actual incident. Usually during a real incident, we would have our sensory perceptions to guide us. There's more of an instantaneous response to a real emergency. But during a drill, everything is more relaxed. You just follow along with the scenario. No matter how hard you try, you can't simulate everything that counts; you learn a lot, but there's always a need to

continued on page 7

MORE ON THE INDUSTRIAL PROTECTION EMERGENCY PLANNING WORKSHOP

In the last issue of the Tie Line, we reported on the Federal Emergency Management Agency (FEMA) invitation (issued through Jim O'Donnell) to SCIEC members to attend this workshop – held at the National Emergency Training Center, Emmitsburg, Md. the week of November 15 through 19. The workshop focused on a planning guide developed for industry and business to use to protect themselves from disasters, with emphasis on *nuclear threats. (Those of you* that attended the January SCIEC meeting know that four of the six attendees from our SCIEC membership reported on what transpired.) We have attempted to summarize the workshop experience here.

The workshop used the Guideline and some disaster analysts to present concepts for industry to apply to ensure survival of some of its production capability in case of a nuclear attack. Concensus *of our SCIEC participants* was that this is a very serious subject about which it looks as if some kind of action is warranted. However, though they felt the Guideline contained some very good material, they also found it unwieldy ("not very handy"), the information frequently poorly communicated, and some serious misconceptions about industry among its contents. Nevertheless, this was a private sector interaction with the public sector (which SCIEC knows a good bit about) with real intent to obtain input from industry. It was definitely "high level"; there were participants from AT&T, Caterpillar, Rohr, Honeywell, Bechtel, Republic Steel, and many more – but nowhere was there anything like what SCIEC provided – the ability to give insight into interfacing between and among industry and local government agencies under major emergency situations. Our SCIEC attendees thought there might be some real opportunities for SCIEC here. Now it seems they were right.

FEMA plans another such conference in April and wishes SCIEC to furnish 20 names of potential attendees from our membership (from different companies, preferably) to which they will send written invitations to attend, with travel expenses and per diem covered by FEMA. Then, in June, FEMA plans to have a second meeting of the attendees from both groups to discuss implementation problems, and accomplishments. If you wish to participate, call Jim O'Donnell or Gretchen Smith, soon – FEMA will send out the invitations in early March.

SCIEC NOTES

• At the last SCIEC meeting the subject was brought up, among other innovative ideas, about the **Tie Line** sponsoring a "Dear Abby" type of column.

Instead of writing about your problems with your in-laws and the traumas of your love life, the type of problems which would be discused would involve your industrial facility: hazmat storage, emergency response planning, etc.

The questions can be sent anonymously to the **Tie Line**. The **Tie Line** will then print them in the next edition (again, anonymously). Then, hopefully, solutions to the problems will come pouring into the **Tie Line** office and these will be printed in the next edition.

Opportunities for sharing ideas and solutions are what this organization is all about. The **Tie Line** hopes that you will get involved with this great new information resource in order to make it a success.

• South County Industrial Emergency Council is obviously expanding. We have many members from Santa Clara County, several from San Francisco County, and a few from the East Bay counties. Is it time to change SCIEC's name to Bay Area Industrial Emergency Council? Come to February's meeting and voice your opinion on whether the name of our organization should remain the same, or if changed, what should our new title be.

• It's time to start gathering data for SCIEC's hazardous material information Resource Center, part of our three phase, County-wide program to provide better hazardous material response. The next **Tie Line** will include an article on what types of information we want you to submit and why. We will all be able to benefit from this resource collection of records of past spills and effective response protocols.

AMERICAN INDUSTRIAL HYGIENE ASSOC.

AIHA – Northern California Section is offering a Spring Symposium on April 6, 1983. Entitled "Managing Health and Safety in a Complex Techno/Legal Environment", it will be held at Dunfey Hotel in San Mateo, between 8:15 and 4:30. Pre-registration is $40 and includes lunch. For further information contact Mas Koketsu at (415) 962-3188.

SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL

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The "Tie Line" is a quarterly publication of the South County Industrial Emergency Council (SCIEC), a non-profit educational organization dedicated to fostering cooperation between industry and government in the field of emergency preparedness. Letters, articles, and announcements from readers are welcome. Limited advertising space is available at $25.00 per quarter page, camera-ready copy.

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RAPID SHUTDOWN

Where safety problems, equipment damage, or major production losses can arise from unscheduled shutdown, an effective procedure for emergency shutdown is probably the number one countermeasure a facility needs developed - because it applies to the greatest number of emergencies (fire, flood, earthquake, power outage, hazardous material spills, etc). As industries in our area are heavily involved in electronic component production, and both product and equipment can be irreversibly damaged by interruption of production in process, this loss mechansm poses a high potential dollar risk in an emergency situation - if shutdown procedures are inadequate.

With the recent heavy rains and the widespread power outage that resulted, this subject area seemed worth examining, particularly with regard to how **our** members faired. We thought that if we could get a clearer picture of some of our generic problems, we might be able to give it better coverage - either through the Tie Line, or at the upcoming seminar. So, a questionnaire was sent out to several of our members who are the environmental and safety experts at their plants. The questionnaire was aimed at finding out approximately how many plants were, in fact, prepared for an emergency shutdown, whether they suffered a power outage, how long did it take them to shut down, what problems were (or would be) caused by rapid shutdown, and how long it took, or would take, them to start up production—if, indeed, they **could** start up after an emergency shutdown.

The questionnaire raised sixteen questions that we thought, if answered, would provide a better picture of our problems, and we were particularly interested in the possible damage mechanisms, such as:

- o fire
- o explosion
- o coagulation and hardening of materials
- o thermal damage
- o freezing of melt in furnaces
- o clogging and fouling
- o corrosion
- o warping

However, aside from **safety**, the most critical concern is damage that **may not permit startup after the emergency.**

In answer to what **safety** problems were associated with emergency shutdown, the answers varied from, "Our problem would just be the difficulties encountered with poor vision due to insufficient lighting," to, "Some production processes are very chemically reactive and exothermic; electrical shutdowns at the wrong time can be dangerous since our cooling water pumps, vacuum pumps, and reactor agitators are electrically powered." But, clearly, the most frequent problems identified by the facilities questioned were the three items we placed at the top of the list above. Moreover, for many of these companies, an outage only has to last a few minutes before significant damage can occur, though the magnitude is dependent on the particular stage in the process at the moment of outage.

Because emergency preparedness is really just another form of insurance, the key objective is to cover the **worst** things that can happen to you. The worst case we identified for some of the companies questioned is a critical process (and the equipment) that cannot **ever** be shutdown rapidly. (For this situation, **you must have a standby power system.**) One of our questions was aimed at just what kind of shutdown time is required, generally. Our companies varied in their answers; the range was pretty much from 10 minutes to 4 hours (with one industry taking 8 hours for a shutdown).

In response to whether an emergency shutdown procedure had been developed, the answers covered the entire spectrum - "yes", "no", and "partially." Yet, **all** of our respondents said that their production capability is heavily dependent on electric power, and **most** said that **100%** of their production would be interruped during an outage. Apparently, most of our responding companies **have** trained their employees on what to do with their equipment in case of an emergency. We also found that most of these companies send their employees home during any power outage that lasts longer than two hours (and we would suppose this would hold for any other type of emergency interruption, e.g., a fire or flood). We note that if employees are sent home without pay, this could be a big loss to the employees and affect company/employee relations.

We *looked at a study by the Electric Power* Research Institute on this topic to share with our readers and found that, in some cases, the cost of extra overtime production to make up lost production was actually less than the cost of lost sales. So by resorting to overtime production, frequently the customer can be satisfied by delivery of his product, employees are able to make back the wages lost - with an overtime "bonus", and the company dollar loss can be lessened while company/employee and company/customer relations remain good.

As you might imagine, as far as countermeasures to the problem of shutdown due to power outages are concerned, all respondents have considered on-site power generation, but most of them said that this wouldn't be sufficient in any prolonged electrical power outage. Even so, for short term emergencies, every industry should evaluate the potential of stand-by power's use to reduce outage impacts. Sometimes it won't be feasible due to economical reasons, but your company will find it worthwhile to develop an emergency shutdown procedure and to evaluate the cost of an emergency standby power supply for critical processes (e.g., crystal growing) versus the cost of a shutdown.

continued next page

SCIEC DISASTER SEMINAR AND DRILL: THE 5th ANNUAL

The 1983 Disaster Drill Planning Committee met in early January to discuss and finalize some of the items for this year's disaster seminar and drill. Agencies represented at the meeting included: SCIEC, San Mateo Area Disaster Office (which is jointly sponsoring the drill), local fire departments, the medical community, the police department, and private industry.

The dates set are May 4, 5 and 6. Speakers from various backgrounds will fill the first day's session (Wednesday) with discussions on such topics as Superfund, hazardous material regulations, and "who's who" in the emergency response legislative circles. On Thursday different agencies will give short talks on their responsibilities during emergencies, which will be followed by an early evening barbeque. And, then, next on the agenda, the big event—the disaster exercise. This year's exercise will be SCIEC's first night drill. During the drill the hazardous material emergency plan will be tested along with a simulated evacuation. The scenario will include a railroad car incident. On Friday morning the drill will be critiqued.

Eureka Federal Savings is the planned site for the Wednesday and Thursday seminar. The evening drill takes place on Bay Road – between Raychem and Ampex Corporations. The morning debriefing is at Raychem, at their 300 Constitution Drive location. Busses will be available for transporting participants between Eureka Federal and the drill site.

Stay tuned for further details on speakers and scenario possibilities. In April you will be receiving a registration form. The cost is estimated at approximately $100 for the entire seminar and drill. For more information, contact either Jim O'Donnell of SCIEC at (415) 592–4892 or Kent Paxton at the Area Disaster Office, (415) 363–4790.

RAPID SHUTDOWN, continued

To compose an emergency shutdown procedure, a flow chart should be developed which includes all possible questions which may come up during the emergency. To consider all the possible "if–thens" can be a major time–consuming job. And in many large companies, each separate process facility has it's own shutdown procedure. But often the critical "if–thens" are straightforward and the task not too difficult.

Once you **do** get a sequence which must take place in the event of an emergency shutdown, your workers need to be informed on what to do with the equipment they use, the material in–process, etc., and they should be trained through in–plant drills and lectures. Instructions should be posted where they will be noticed.

Tie Line would like to end with note of appreciation to those who filled out the questionnaire, and suggest that we would like to hear from those who want to get further into this subject – and should we do it at the seminar?

CHP, continued

learn a little more. Actually, within minutes of arriving at the command post, I suggested we move farther away from the scene. But because this was a drill, we chose not to move, simply for time's sake.

T.L.: How did the officers at the command post decide what action should be taken?
B.K.: Obviously, the more information you have in a situation the better your decisions will be. So it boils down to one very simple thing—try to get every expert you can find that can help make these weighty decisions. But there's a limit to how many of these experts we can allow into the command post area. At the command post, I used the CHP capabilities (two–way radios) to communicate with people outside the command post area. When you are a scene manager, limiting the number of people that are around you allows you more time to think and analyze the information you are given.

T.L.: Do you see some possible areas which you would like to see further work on for the next SCIEC drill?
B.K.: To that question, I have to answer no. I think there is sufficient challenge in these scenarios to allow them to continue as they are. The more you get involved and the more you do, the fewer mistakes you make. I think it's like anything else– –through practice certain functions become automatic. The most important thing about these scenarios is the involvement of many key people. Through drills of this type and through SCIEC's regular activities, we are doing exactly this—getting agencies together and pooling our resources.

AMERICAN RED CROSS

o *Providing Health Services in Time of Disaster*
ARC is sponsoring a course for industrial nurses on community disaster response. This ten hour course is being offered on February 18 and 25 and is intended to prepare nurses to provide emergency and preventive health services as well as emotional support to disaster victims and workers. Another course is set for April 15 on the topic of hazardous materials response. The February course is a prerequisite for the April course. The Sequoia Service Center which is located at 3540 Middlefield Road in Menlo Park is the site for all three meetings. If you wish to enroll or have any questions, you may call Pat Robinson at (415) 366-3851.

Companies faced with potential mishap should consider enrolling their employees in the American Red Cross courses listed below. The courses will be taught at the location, day and time of the company's choosing. For a more complete course description, course lengths and costs, call John Buckingham at (415) 776-1500—x226.

o Metropolitan Survival
Metropolitan Survival teaches immediate first aid for the following life threatening emergencies: breathing, bleeding, poisoning, choking and burns. It also explains how to enter the Emergency Medical System for help anywhere in the country.

o CPR Modular System
This course for employers and employees teaches the proper techniques to provide blood circulation and breathing to victims of cardiac arrest, shock, or related cause. Additionally, the course teaches emergency airway procedures and increases awareness of early warning signs, risk factors and symptoms. Successful completion of the course merits American Red Cross certification in CPR.

o Race For Life
This modified version of the CPR course teaches mouth-to-mouth resuscitation and one-rescuer CPR for an adult victim and uses the lecture-discussion-practice system. This course uses the sam materials as the above CPR course but does no include techniques for children or infants.

o Multi Media First Aid
This course is designed to prevent or minimize on the-job accidents, thus curtailing personal injur loss of employee time and the incursion of financi expense. Successful completion of this cour merits an American Red Cross certificate Standard First Aid.

EMERGENCY PLANNING FACT SHEET from SSI
This issue contains a complimentary Power Outage Fact Sheet. It's your choice: you can read it, or stay in the dark!

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SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL
FIRE SERVICES - INDUSTRY

POWER OUTAGE

SCIENTIFIC SERVICE, INC. 517 E. BAYSHORE REDWOOD CITY, CA 94063 (415)368-2931

Outage Risk

Short term power outages, lasting minutes to days, can occur as an outgrowth of any major areawide disaster (flood, ice storm, hurricane, earthquake, tornado, etc.) that may affect one or more entire utility generation and distribution systems. Short term outages can also occur as a local phenomenon, lasting from minutes to hours, as a result of a minor neighborhood incident (construction or aircraft accident, lightning bolt, fire, explosion, act of vandalism) that knocks out a power line, substation, transformer, switchgear, etc. Long term power outages, measured in days or weeks — would likely culminate in rotating blackouts and could result from international political or economic decisions, or an event such as TMI. As there is no clear cut basis for tying power outages to well documented (statistically based) risks alone (e.g., natural disasters), risk assessment is best established in terms of emergency shutdown costs. Such costs are likely to be highest when sudden loss of power is especially critical to some processes, for example if it would completely ruin the product run, damage production equipment (or even, perhaps, become extremely dangerous, should substances become unstable without power for automatic process operation and control of cooling, heating, adding of inhibitors, etc.). From power outage studies conducted by the Electric Power Research Institute, about 10% of the companies caught in a sudden power outage could have justified an onsite standby system based on lower total cost than the product and equipment losses suffered. Half of these companies needed standby capacity nearly equal to total demand, while the other half needed only enough standby capacity to run a small fraction of their operation that had a critical demand for power. It is not surprising that the latter group already had standby systems onsite and ready.

To determine if your plant (or division) should consider a standby system, you need to conduct an emergency shutdown analysis and assess the safety aspects and economic impact of a sudden power outage. Clearly, if a **small portion** of your operation cannot stand a sudden shutdown without a high penalty cost, then there is a fair likelihood a standby generator will be easily justified. If **most** of your operation cannot stand to be shut down suddenly without causing a high penalty cost, there may still be possibility that standby power is justified. If **all** operations can be shut down at any time without warning and with no effect other than minor annoyance and temporary cessation of operations, you don't have a serious risk from power outage — excepting that you may have a serious personnel safety problem with sudden loss of lighting, depending on whether operations are conducted at night, in windowless buildings, or under any other conditions where artificial lighting is required for safe exit from the workplace. In such instance, at least a battery powered continuously charging backup lighting system would be required as an emergency measure.

Outage Considerations

Power outage is not the only reason to consider onsite power generation capability. A variety of incentives has appeared since the first energy crisis surfaced to make consideration of onsite generation worthwhile. When there is a combined demand for electricity and process heat or when fuels are available that are particularly inexpensive (e.g., solid wastes or natural stream flow), onsite systems could save you money, slow the growth of your energy costs, and provide protection against curtailment, international incidents or rotating blackouts. Moreover, if you require significant quantitites of both electricity and process heat, you might want to consider the combined benefits of emergency preparedness and greater efficiency obtainable with cogeneration systems. Where onsite power generation is used in conjunction with utility supplied power, the onsite system could also supply additional power for short periods in emergencies because most generating units can operate for several hours at considerably more than rated output (long enough for most utility power outages). Likewise, the utility supplied power could be increased in an emergency involving failure of the onsite system.

Fairly recent regulations affecting utilities make it easier to do some this. Under PURPA (the Public Utility Regulatory Policies Act of 1978), utilities are required to take actions that will encourage energy conservation (among other things). As an example of what might be accomplished, in northern California the Pacific Gas & Electric Co. will pay a flat annual premium of $10,000 to any industry with a 100 kW generator (or larger) that will agree to operate its onsite generator continuously to supply all or part of the onsite power demand in the summer, when the utility has heavy demand. This arrangement combines industrial energy conservation, emergency standby power, or both, with load-leveling at the utility to provide economic benefits to both parties. This is a **negotiated industry/utility joint saving.** Similar possibilities may exist in your area — so find out what your utility is doing under PURPA! As an added incentive, PG&E provides a guarantee that, while such standby units are operating under contract, power costs will not be any greater than had the onsite power been purchased from the utility.

Some industries have paid special attention to producing power onsite by means of fuels that are not likely to be interrupted by an international incident (such as happened in Iran) and seek to develop opportunities using low head hydro power or cogeneration based on burning locally available solid fuels. As a result of the energy crisis of the early 1970's, there are many more opportunities today for a company to make itself less vulnerable to the increased risk of power interruption, for any reason, and to realize dollar savings in the bargain. Two matrices have been provided with this factsheet to help you identify some of the options and tradeoffs — you might also benefit by a discussion with your local utility representative.

TECHNOLOGY	BENEFITS	DRAWBACKS
STEAM TURBINE	Long Life; Can Burn Coal, Solid Wastes	Low Efficiency; Less than 10 MW Uneconomical
GAS TURBINE	High Temp. Heat; One to 10 MW OK; Efficiency OK	Petroleum-based Fuels Only
DIESEL ENGINE	High Efficiency; Sizes down to 100 kW OK	Low Waste Heat Petroleum Fuels Required

INDUSTRIAL ONSITE POWER ALTERNATIVES

ALTERNATIVES	TYPE SERVICE	AVAILABLE SIZE RANGE (KW)	GEOGRAPHICAL CONSTRAINTS	CONSIDERATION & PROBLEMS	COST $/KW AT KW SIZE	INCENTIVES 1/	IMPLEMENTATION LEAD TIME	FUEL SUPPLY TYPE & VULNERABILITY TO CUTOFF	EQUIPMENT DISASTER VULNERABILITY
COGENERATION	RELIABLE EVERYDAY	50 TO 500,000 (PRACTICAL RANGE)	NONE	NEED PROCESS HEAT DEMAND > 50,000 LB/HR (STEAM), ENVIRONMENTAL ISSUES		FEDERAL (INVESTMENT TAX, OCCASIONAL ENERGY TAX) PLUS LOCAL STATE & UTILITY PROGRAMS	2 YEARS MINIMUM TO OVER 5 YEARS 2/	LIQUID .... SEVERE GAS ..... HEAVY TO MODERATE SOLID ... MODERATE TO LIGHT	SIZE AND LOCATION DEPENDENT SHOULD BE INSTALLED IN HARDENED OR HARDENABLE STRUCTURES
RANKINE TOPPING		50 TO 15,000			175 AT 50 110 AT 15,000				
INTERNAL COMBUSTION		150 TO 25,000			600 AT 150 800 AT 1,300				
RANKINE BOTTOMING		500 TO 15,000			710 AT 500 490 AT 15,000				
GAS COMBUSTION (TURBINE)		500 TO 100,000			400 AT 500 300 AT 18,000				
REFRIGERATING STEAM		5 TO 5,000			580 AT 1,000 220 AT 5,000				
COMBINED CYCLE		1000 TO 150,000			440 AT 2,500 340 AT 20,000				
FUEL CELLS		15 TO 5,000			544 AT 5,000 TO 25,000				
HYDRO	RELIABLE EVERYDAY 3/	200 TO 15,000	HEAVY, LOCAL, STREAM SITE	NEED RIVER & RIGHTS	1,000 TO 2,000 AT 5,000	*	~ 2 YRS RUN OF THE RIVER 6-7 YRS OTHERWISE	WATER FLOW ..... LIGHT TO NIL	VERY LOW
WIND	SPORADIC 4/ EVERYDAY	100 TO 2,000	MODERATE, REGIONAL	MINIMUM WIND 8-10 MPH MAXIMUM WIND 20-30 MPH STORAGE LIMITED	1,000 TO 3,000 AT 2 TO 10	*	> 3 YEARS	AIR FLOW .... NONE	LOW
GEOTHERMAL	RELIABLE, EVERYDAY	50,000 TO 20,000	SEVERE REGIONAL	NEED WATER AND MINERAL RIGHTS	UNKNOWN	UNKNOWN	> 3 YEARS	GEOTHERMAL ...... NIL	VERY LOW
STANDBY ENGINE GENERATOR	PERIODIC NONSTEADY EMERGENCIES	5 TO 10,000	NONE	ENVIRONMENTAL ISSUES	PER SET (1980) — see below	INVESTMENT TAX PLUS LOCAL UTILITY	1-7 DAYS, RENTAL 2-10 WK. PURCHASE	LIQUID .... SEVERE GAS .... HEAVY	HARDEN
CONVERTED INDUCTION MOTOR	EMERGENCY ONLY	1 TO 300	NONE	NEED CONVERSION KIT, PRIME MOVER SPARE MOTOR	UNKNOWN	NONE	1-2 DAYS WITH CONVERSION KIT	DEPENDS ON PRIME MOVER ..... HEAVY TO SEVERE	HARDEN

PER SET (1980)

GASOLINE	DIESEL
0-5 KW $491	
5.1-15 KW $1,574	14 KW $3,493
15.1-35 KW $2,950	14.1-50 KW $7,350
35.1-100 KW $7,587	50.1-100 KW $12,896
100.1 → $44,578	100.1-200 KW $16,603
	200.1-400 KW $28,947
	400.1-1000 KW $62,715
	1000.1 → $330,487

1/ FOR UNITS OVER A CERTAIN SIZE, CALIFORNIA UTILITY PROGRAMS OFFER GUARANTEED POWER COST PLUS $10,000 ANNUALLY TO STAY "OFF-LINE" DURING PEAK DEMAND SEASON

2/ MINIMUM TIME FOR SMALL UNITS AND WASTE HEAT UNITS, LONGER TIMES ARE FOR LARGE SYSTEMS

3/ SUBJECT TO SEASONAL INTERRUPTION ON SOME STREAMS

4/ SUBJECT TO DAILY INTERRUPTION

Section 10
VULNERABILITY ASSESSMENT

There are two aspects to vulnerability assessment studies that are of interest in this program. One of these centers on simplified methods for conducting the assessments, and the other on the quantitative assessment of vulnerabilities associated with new hardening concepts or schemes.

ASSESSMENT SIMPLIFICATION

In the original Industrial Protection Guide, four "booklets" take the industrial planner from an inventory of his equipment through the hardening decision process. The procedure was developed as an initial attempt at a methodology to help the end-user organize the decision process regarding which equipment to harden. A faster procedure is needed (particularly for those end-users of the Guide who have some clear-cut ideas about what they wish to save and what they can afford to abandon).

In the procedure developed initially, an inventory of **all** equipment must be made -- followed by an assessment of the vulnerability of **each** item. This information is then used to develop a rating to enable the inventoried equipment to be ranked in order of hardening priority (the ranking procedure combines two factors, the importance of each item to production, and its repairability). Resources on hand are then allocated successively (again, among **all** the equipment) to raise the most vulnerable items to a uniform, minimum level of hardness. This may require several replications to arrive at a near optimal use of resources to achieve hardening. This procedure is one that can be used when one does not know at all where to commence, but it is not a procedure that can be executed rapidly.

A short procedure is needed that shows the end-user, directly, the upgraded vulnerability achievable by each hardening option open to him (with some idea of the

resource expenditure required for each). Because there are actually only a limited number of options with many versions of each, a short procedure is at least feasible. It may, however, require considerable effort to develop the necessary hardening catalog, but once developed it could become a considerable time saver at the time of execution. As this saving at a plant would be multiplied manyfold at a myriad of plants, it might prove well worthwhile.

Conceivably, by dividing equipment into two groups, those crushable by the static overpressure and those that are not, the hardened vulnerability for each hardening option could be listed **directly** in terms of the three types of damage mechanisms for each category of equipment (throughout Booklet 8 of Ref. 1). Thus **hardened** vulnerability could be linked directly to resources required for the hardening task, by **item** in the equipment index, and the tradeoff options in allocating available resources to harden critical items of equipment would become the starting point in the hardening procedure. The benefit of this alternative is that it renders unnecessary the time consuming assessment of equipment vulnerabilities of all the equipment in the plant for the unhardened case. What the new approach would entail is:

- o Changing the "Vulnerability/Blast Rating Catalog" to list a hardened blast vulnerability against pressure/drag/missiles for **each hardening option** (for example, per Table 13).
- o Reorganizing the existing catalog (Booklet 8 from Ref. 1) from one that is ordered according to increasing size of item, to one ordered according to decreasing unhardened vulnerability — and dividing the catalog into two parts, one for equipment that is vulnerable to static overpressure and one for equipment that is not.

A salutary benefit is that this would simplify the development and addition of a column to identify other disasters for which the hardening procedure would be beneficial in protecting equipment.

As part of the overall procedure and modifications, the booklet on hardening options (Booklet 9 from Ref. 1) would contain single page pictorials of all the

Table 13

Hardening Options and Vulnerabilities

Hardening Option	Hardened Vulnerability Rating		
	Pressure A	Drag B	Missile C
(1) Move to Host Area	safe	safe	safe
(2) Below grade shoring of slab cover to 40 psi	all 40	50	50
(3) Bury in crushable packing with 2 ft of dirt cover	2 → 10 10 → 50 50 →100	50	50
(4) Bury (above or below) ground (inside or outside) with 3 ft of dirt cover	2 = 2 10 = 10 50 = 50	50	50
(5) Bury (inside or outside) under 2 ft (lumber or tires) for cover	2 = 2 10 = 10 50 = 50	50	30
(6) Skid into ditch or cluster behind berms located > bldg height (H) from bldg. No cover but (ditch/berm) height 3 ft > equipment	2 = 2 10 = 10 50 = 50	50	for bldg H < 60 ft 50
(7) Same as (6) but (ditch/berm) < bldg height from bldg	2 = 2 10 = 10 50 = 50	50	some probability of missile damage but too complex to figure.
(8) Cluster without cover in open at >H from structure and > one cluster diameter from other equipment clusters	2 = 2 10 = 10 50 = 50	50	Considerable probability of missile damage but too complex to figure
(9) Cluster without cover	2 = 2 10 = 10 50 = 50	≈20	≈10

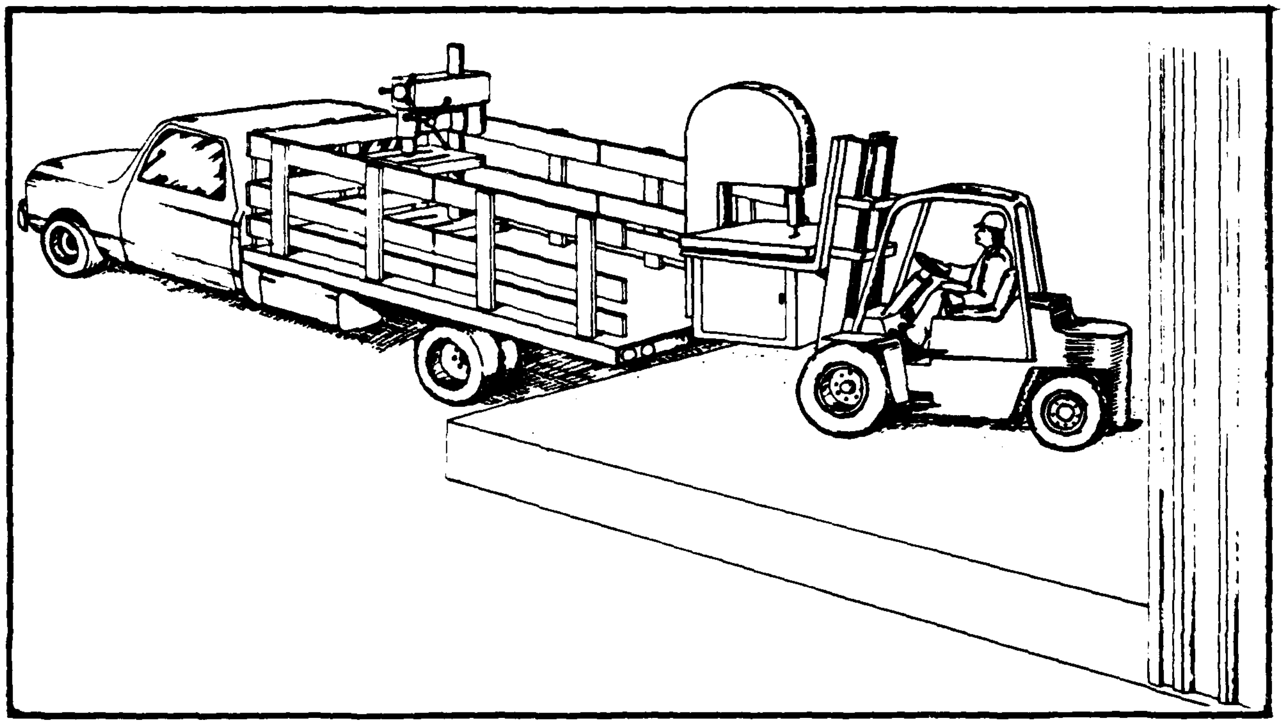
hardening options (with three or four versions or variations on each) that could be mounted on the wall for easy reference while making hardening decisions. Figure 7 shows an example of one of the simplest effective options. By assigning a simple letter or number (i.e., coding) to each of these options in the pictorials, then a simple table can be provided on each page of the equipment catalog of Booklet 8 to indicate the vulnerability of each class of equipment in each of the hardened modes pertinent. Table 13 indicates a range of options and vulnerabilities that are likely to be practical to achieve. As not every option would be pertinent to each piece of equipment, the equipment catalog would have to be revised to indicate which ones applied. Figure 8 shows a typical double page entry from the current version of the Booklet 8 catalog and Figure 9 shows how it would appear in the new catalog.

With the revised catalog, one strategy for applying the procedure could be based on development of equipment inventories into production units constituting redundant production capability. Then, one production unit would be paired with the necessary (and available) hardening resources for survival by referring to the various hardened vulnerabilities versus hardening options coded in Booklet 8 (and identified in the pictorial form of the hardening options from Booklet 9, mounted on the wall). If hardening resources are exhausted before all the equipment in the basic production unit have been allocated enough resources to complete a hardening option, then it is much simpler to make tradeoffs, using the first pass-through as a reference basis, to optimize the end results. If all the equipment in the basic production unit can be hardened and additional hardening resources remain, this approach will simplify the decision whether to expend these resources to harden the same unit to a higher level, or to harden additional equipment.

QUANTITATIVE ASSESSMENT OF VULNERABILITY

There are two principal options for protecting equipment (or people) from a nuclear attack: dispersed relocation to reduce the odds of being in an impacted (risk) area, and shielding from the various damaging effects (e.g., pressure, drag, missiles, fire,) when relocation is not possible. Virtually all other options are some kind of derivative of these two. In the category of shielding, studies of permanent

EVACUATE



LOAD EQUIPMENT AND MOVE IT AWAY

If you can take all of it — Do So!

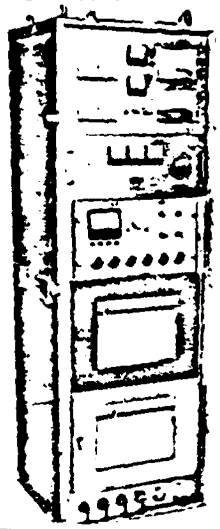
If you can take only part of it, select the irreplaceable items — key maintenance and repair manuals and tools, recovery equipment — and evacuate those.

Fig. 7. Evacuation Pictorial.

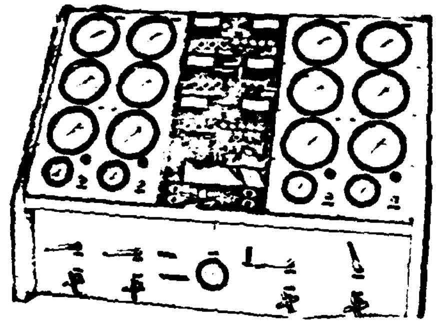
TYPE: ELECTRICAL/ELECTRONIC PANELS & RACKS — EQUIPMENT PAGE NO. 2B-2

Maximum Dimensions: (15x15x20) Feet — Maximum Weight. 30,000 Pounds

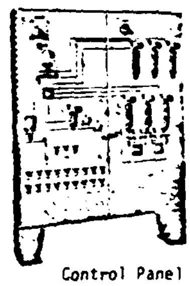
EXAMPLES
Control Panels
Instrumentation Panels
Instrumentation Racks



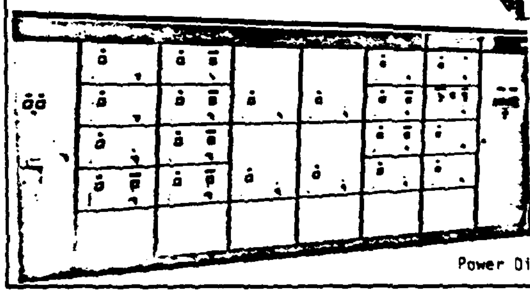
Instrumentation Rack



Instrumentation Panel



Control Panel



Power Distribution Panels

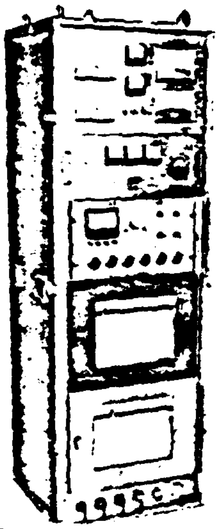
GROUP: 2B-2 ELECTRICAL/ELECTRONIC PANELS & RACKS	BLAST LEVEL (PSI)			RECOVERY	
	BLAST w/o MISSILES		MISSILES		
DAMAGE DESCRIPTION	SECURED	NOT SECURED		MANHOURS	DAYS
HORIZONTAL CONFIGURATION (H/B ≤ 2)					
1. Little or no damage:					
2. Light to moderate damage: Meter movements broken; cover glasses broken; metal covers/panels bent; instruments decalibrated.	2	1	1	16	2
3. Moderate to heavy damage: Faces of panels bent/buckled with corresponding damage to elec. components; controls broken; covers & cases pushed into elec. components; breakables fractured; circuit boards cracked/broken.	4	2	2	24	4
4. Destroyed:					
OVERALL BLAST RATING WITH PROTECTIVE HOUSEKEEPING	3	2		3	< 1
VERTICAL CONFIGURATION (H/B > 2)					
1. Little or no damage:					
2. Light to moderate damage:	1	1	1		
3. Moderate to heavy damage:	3	2	2		
4. Destroyed:					
OVERALL BLAST RATING WITH PROTECTIVE HOUSEKEEPING	2	2			

PAGE 2B-2 ELECTRICAL/ELECTRONIC PANELS & RACKS

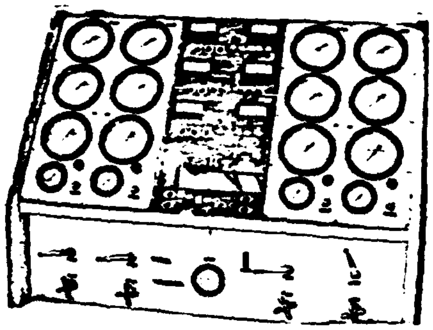
Fig. 8. Equipment Classification and Vulnerabilities.

TYPE:	ELECTRICAL/ELECTRONIC PANELS & RACKS	EQUIPMENT PAGE NO.	28-2
	Maximum Dimensions: (15x15x20) Feet — Maximum Weight: 30,000 Pounds		

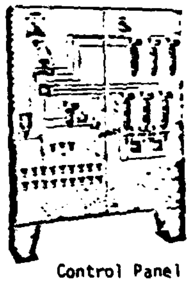
EXAMPLES
Control Panels
Instrumentation Panels
Instrumentation Racks



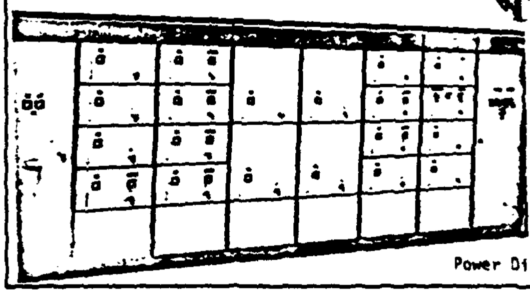
Instrumentation Rack



Instrumentation Panel



Control Panel



Power Distribution Panels

TYPE: ELECTRICAL/ELECTRONIC PANELS AND RACKS

HARDENING OPTION	HARDENING VULNERABILITY RATING
Evacuate (to Host Area)	Safe
Below grade with support slab cover	40
Crushable packaging with 2 feet of cover	10
Remaining options	2

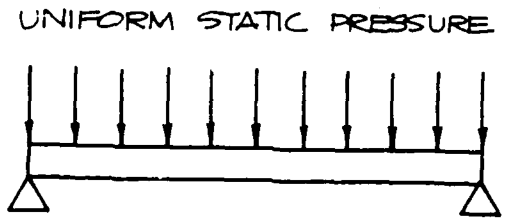
Fig. 9. Simplified Hardening Options Assessment.

facilities built underground in Oklahoma to provide tornado protection showed that the overhead floors in these structures could be strengthened in a matter of hours by shoring (Refs. 1 and 12) to provide blast protection up to 36 psi (Refs. 14 and 15). Presumably, anything (or anybody) inside such a strengthened structure would survive a 36 psi blast wave. This assumes the walls maintain their integrity, so studies of below-grade wall vulnerability are required.

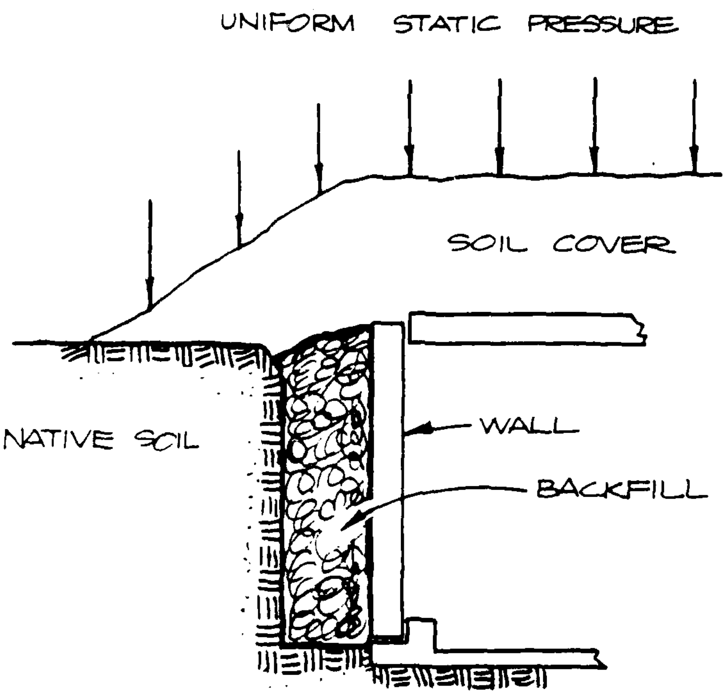
Some studies of below-grade walls constructed of unreinforced concrete were conducted as part of a recent field test to assess failure conditions and to provide input for design of wall shoring (Ref. 16). None of the test walls failed despite an inherent strength sufficient only to resist about 1 psi when applied as a uniform static loading (Figure 10A), even though they were subjected to an overpressure of 40 psi at the surface in the configuration shown in Figure 10B. This observation has important implications for industrial hardening, in that apparently some combinations of geometry and soil conditions will eliminate the need to expend scarce resources for the shoring of below-grade walls to enable them to survive. Additional experiments appear to be warranted to enable the apparent improved performance of these walls to be allocated to the various phenomena known to play a role in reducing the failure probability of below-grade walls.

A sequence of experimental tests was conducted in the SSI 12-inch shock tube on one-twentieth scale models of below-grade walls to provide data on vulnerability to blast waves (Ref. 17). This was an initial study conducted to enable the contribution of several parameters that affect below-grade wall vulnerability to be ranked, with a short-term objective being to identify which parameter or parameters have the major effect. A long-term objective of such testing (which would require many more tests than could be conducted under this program) would be to provide a detailed basis for supplying better design information to the task of reducing structure vulnerability so that a minimum expenditure of resources (i.e., materials, equipment, and especially time) would be required. This could be critical to effective application of the crisis relocation/industrial hardening strategy.

Figure 11 summarizes the inherent variability in failure strength of the test walls when they are simply supported on two edges, and failure is in bending.



A

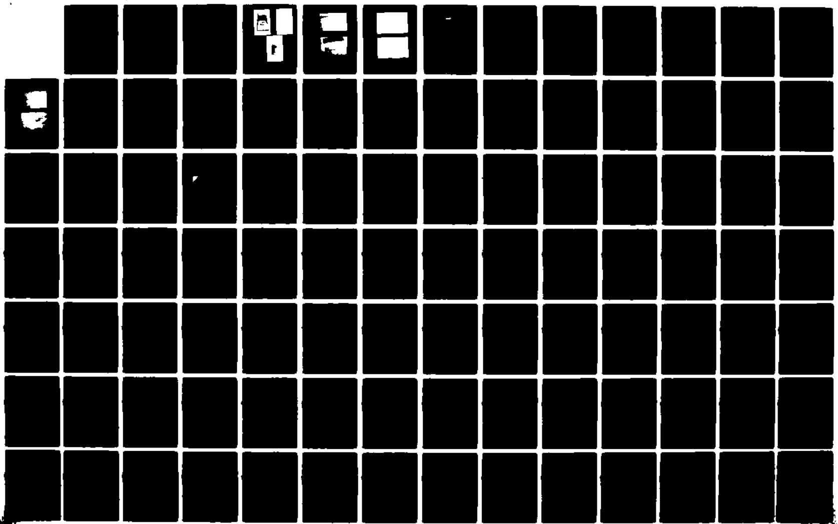


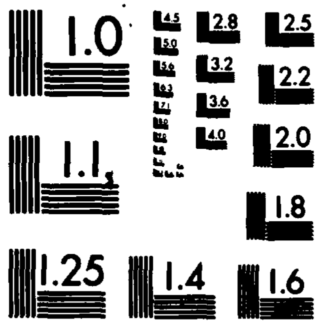
B

Fig. 10. Test Walls (A) Uniform Static Loading (B) Below-Grade Configuration.

AD-A128 969 INDUSTRIAL HARDENING: 1982 TECHNICAL STATUS REPORT(U) 2/2
SCIENTIFIC SERVICE INC REDWOOD CITY CA
J V ZACCOR ET AL. MAY 83 SSI-8145-12 EMW-C-0701

UNCLASSIFIED F/G 15/3 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

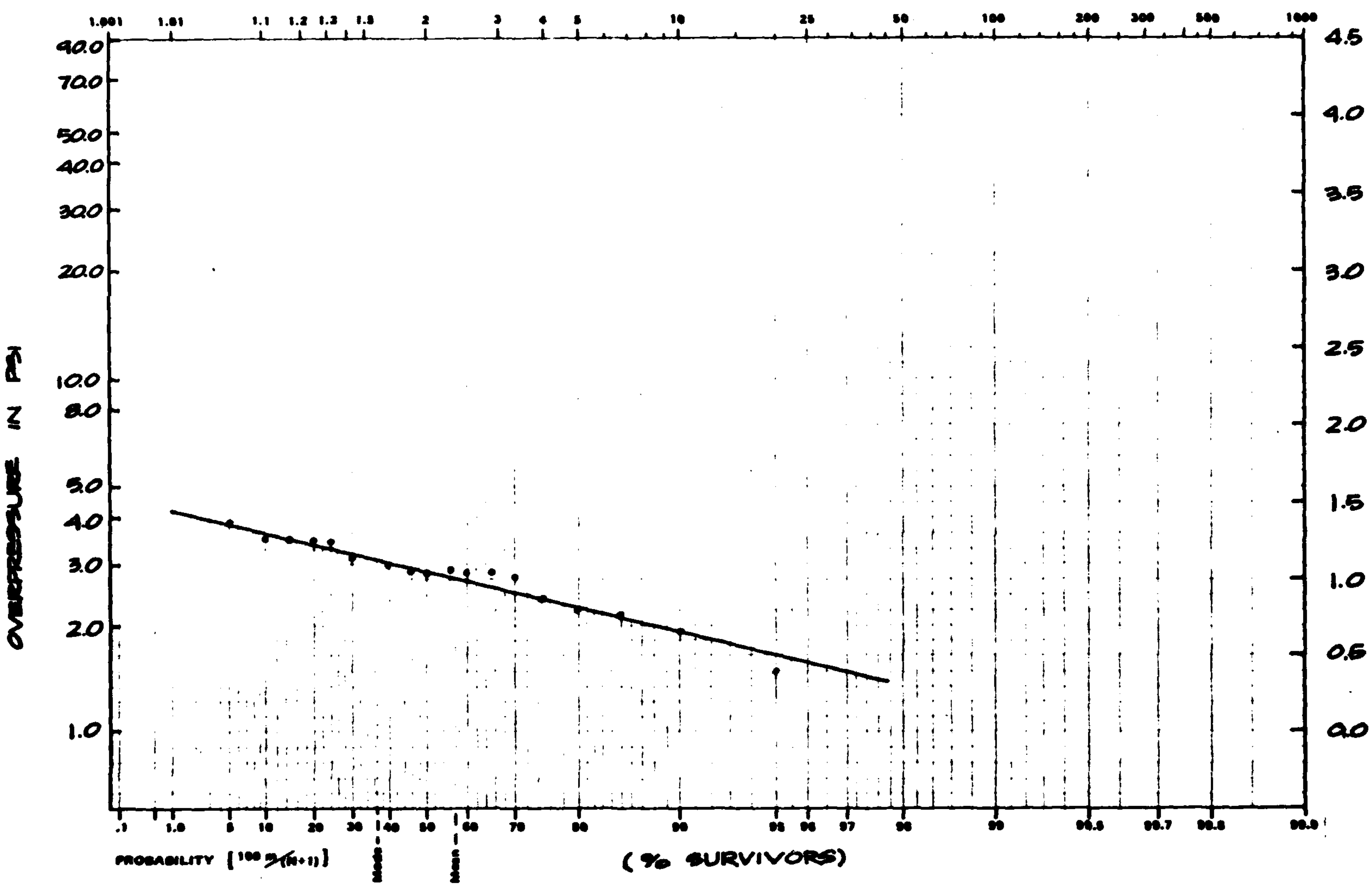


Fig.11. Probability Distribution Curve Governing Survival (Failure) of Walls Uniformly Loaded.

Though these reference tests were conducted as out-of-plane loading at the third points, through use of extreme fiber stress at failure (modulus of rupture) they have been converted to an equivalent uniform loading that will cause failure in bending. Of course, a uniform loading would cause a maximum bending moment at the center, whereas for loading at the third points, the maximum bending moment occurs over the entire middle third of the wall. Therefore, from a statistical standpoint, the failure probability is actually somewhat higher for the third point loading because there is a greater probability of a flaw occurring somewhere in the entire middle third of the member than exactly at the center. But the probability distribution curves for the two situations, though different, are not so different as to matter to the present effort.

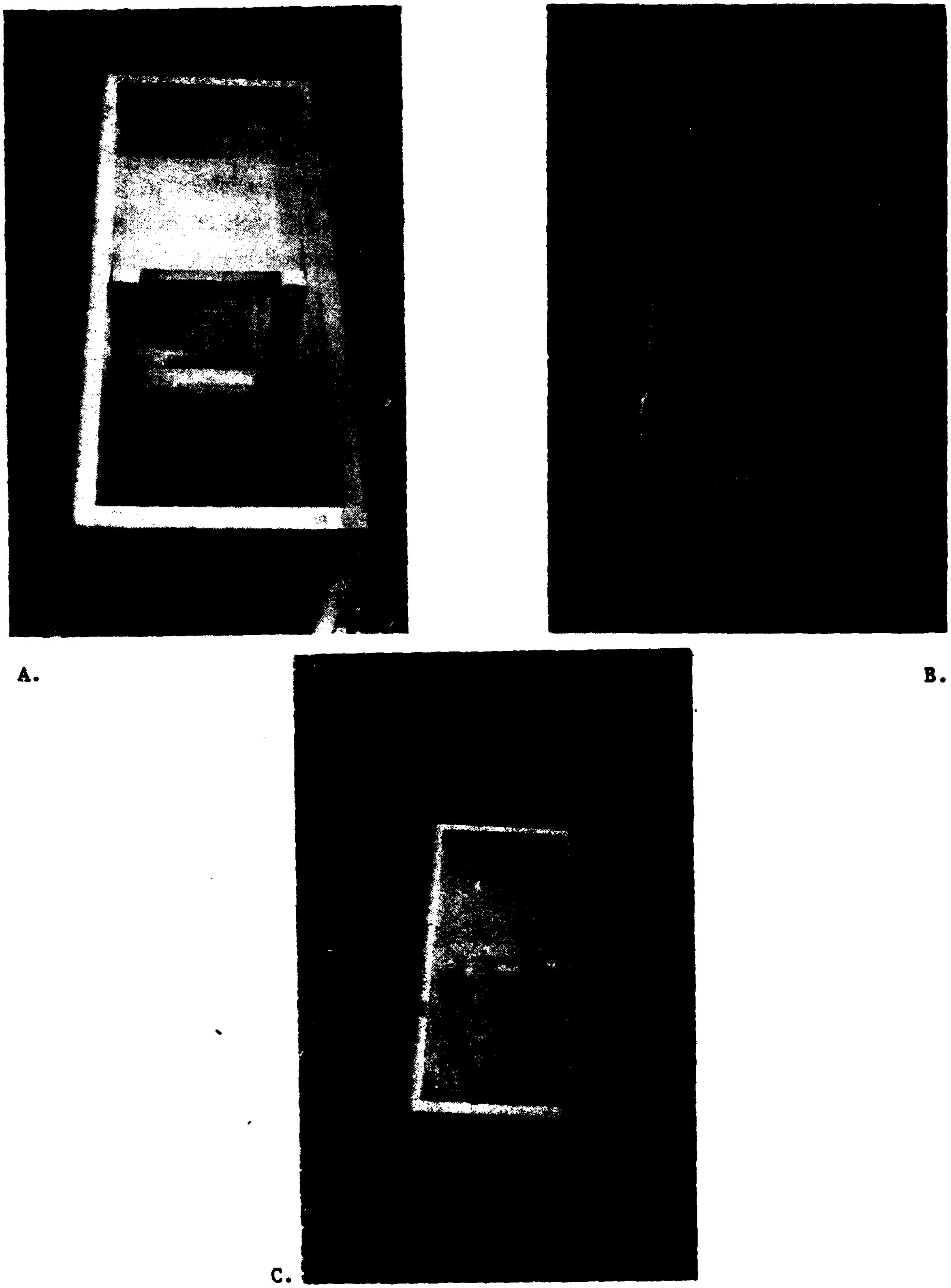
With inherent failure probability of the set of test walls established, tests were subsequently conducted on walls from the same batch in another configuration, i.e., that shown in Figure 10B. To facilitate observation, the entire below-grade assembly was mounted in a box equipped with a transparent sidewall (see the sequence in Figures 12 and 13) so that, as the static overpressure on the surface was gradually increased, observation of wall cracking and collapse could be made (Figure 14). Table 14 contains a typical set of data, and Figure 15 is a plot of cracking and collapse probabilities for static loading on the surface (together with the reference failure curve of Figure 11).

Table 14

Static Below-Grade Wall Tests*

Test Number	Overpressure at Which Indicated Event Occurs: Wall Cracks	Wall Collapses	Chamber Maximum Without Wall Collapse
1	31	--	51
2	35	--	55
3	17	31	--
4	12	--	61
5	21	--	61
6	15	--	60

* Configuration shown in Figure 10.



A. B. C.

Fig. 12. Scale Model Test Fixture Showing: A. Fixture Empty; B. Wall in Place; C. Backfill in Place.

A.

B.

Fig. 13. Scale Model Test Fixture Showing: A. Soil Cover in Place; B. Membrane Seal in Place and Ready to Install in Shock Tube.

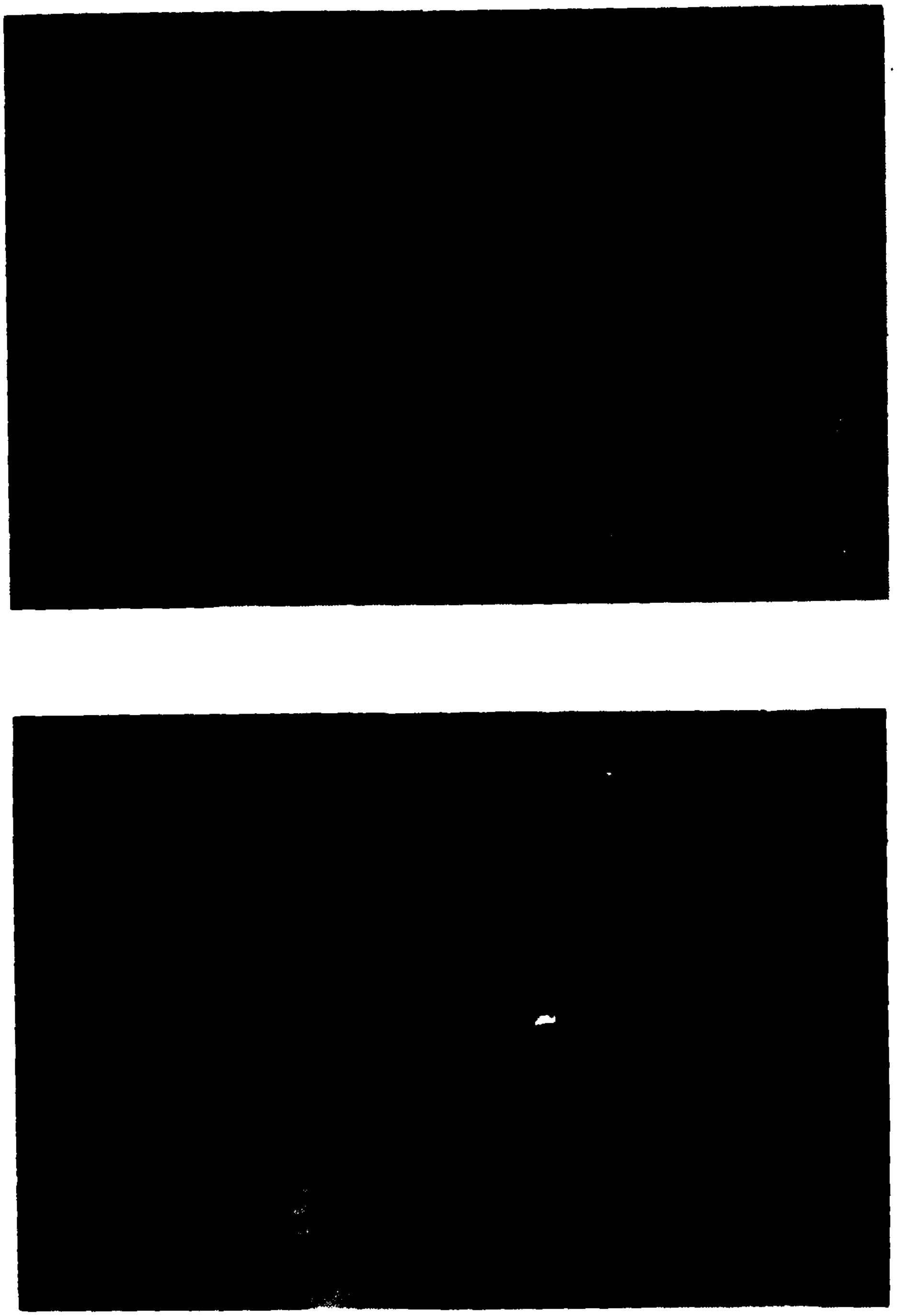


Fig. 14. Looking Through Wall After Test.

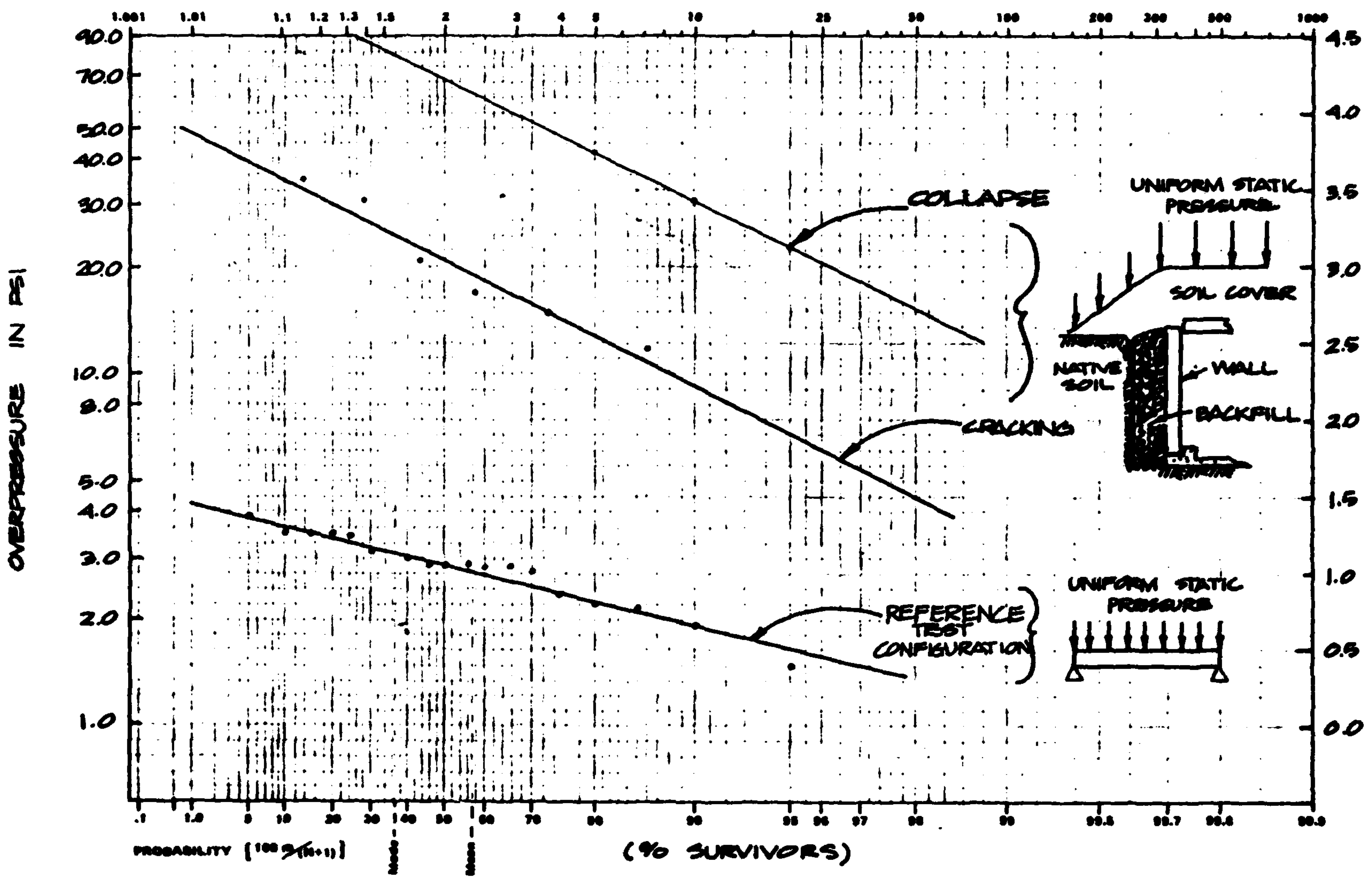


Fig. 15 . Probability Distribution Curves Governing Survival (Failure) of Below-Grade Walls versus Uniform Loading.

Rather significant differences exist between the two wall failure conditions (the uppermost and the lowermost curves), and it would be valuable to know the specific major causes and the contributions of each. These would be the effects of

- o Passive arching in the walls,
- o Active arching in the backfill,
- o Transfer of load down the face of the more rigid wall from the compressible backfill by sidewall friction,
- o Effect of dynamic versus static loading,
- o Motion of the wall away from the adjacent soil,
- o The inherent ratio of lateral loads generated in the backfill due to axially applied loads (i.e., the K_o value, or coefficient of earth pressure at rest).

Using very simple experiments (i.e., without measuring soil stress or wall displacements) the contributions of some of these were assessed while others were effectively eliminated. Thus, experiments were conducted to: assess effects with and without the contribution of passive arching, to eliminate active arching, to examine the effects of the dynamic versus static loadings; and data in the literature were used to assess the effects of load transfer through sidewall friction and the range of expected K_o value effects. (Without soil stress and displacement gauges the role played by wall motion could not be determined.)

Information in the literature (Refs. 18 to 21) suggests coefficients of earth pressure at rest for the dry sand used as backfill in these experiments should range from 0.25 to 0.65. Such information implies that the loading configuration can account for between 1/0.65 to 1/0.25 (i.e., 1.5 to 4 times) out of the 13 times difference observed at the 95 percentile survival loading (or, 23 times difference observed at the 50 percentile survival loading). Studies of columns of compressible materials in rigid walled containers (e.g., grain silos) indicate that load falls off rapidly with distance down a column, because of sidewall friction, so that in a distance equal to three or four container widths, there ceases to be transference of load through the column even if very significant additional load is applied to the material ahead. This circumstance reduces the load on the below-grade wall by changing the distribution (decreasing exponentially with depth). Ref. 22 presents

data in its Appendix A that suggests the effect would be to reduce the out-of-plane loading by a factor of 1.25 to 2.5.

Pulse duration becomes particularly important when loading on a member falls off to a fraction of the peak value before the member has reached maximum deflection. In such case, the member may never reach failure deflection even though the peak load would have been sufficient to ensure failure, had it remained constant. Subsequent to the static loading tests (which enabled the entire failure probability distribution curve to be traced), dynamic tests were conducted (using the same geometry) in which nominal 40 psi surface loadings (at 1/20th scale) were simulated for both nominal 1 kt weapons (actually ranging from 1 to 2 kt, because of experimental variation), and nominal 1 Mt weapons. These tests are described in Ref. 17. Failure under dynamic loading in the range 1 kt to 1 Mt in the scale models was at 0.7 times the static failure condition.

Also according to Ref. 17, passive arching was evaluated by conducting one series with, and one without, passive arching. To preclude passive arching on the wall, a 1/16th-inch layer of styrofoam (reportedly having a compressibility of 20% at 40 psi) was placed on top of the wall and a series of eight 40 psi tests conducted and compared with eight similar tests conducted without the styrofoam insert. The difference measured was a factor of 2.2. Table 15 summarizes the factors individually and in the aggregate.

Table 15
Wall Failure Mechanism Versus Reduction Factor

Mechanism	Reduction Factor
Passive Arching	2.2
Active Arching	1.0
Frictional Transfer	1.25-2.5
Dynamic Loading	0.7
K_o	1.5-4.0
Aggregate	2.9-15.4

Thus, the two most important items to ensure when selecting a below-grade shelter or equipment storage space are that the backfill is well drained, so the K_o factor does not become 1.0, and that load is transferred to the wall via an adequate soil cover with a low angle of internal friction. With appropriate geometry changes, active arching could be caused to occur with benefit, but this was not studied, as soil stress gauges would be required.

Section 11
INDUSTRIAL RECOVERY STATUS ASSESSMENT

There are many options that could accelerate industrial recovery in a postattack situation; prudence suggests we should be prepared to use all options conceivable. A very valuable option would be the capability for rapid replacement of items likely to be in short supply. If the items could be identified in advance, this might be accomplished by stockpiling them (in a safe place), or they could be scavenged from other plants, postattack — either from fringe areas where plants have ceased to function, or from plants in unaffected areas that are involved in less essential production operations. To gain insight into the effectiveness that might be expected from employing either of these replacement options, some kind of damage assessment study is needed that is indicative of losses suffered among industries involved in very essential production so that items that might become in short supply could be identified. For stockpiling, this would be sufficient — but for scavenging, it would be desirable not to limit the damage assessment to industries involved in essential production.

At least one industrial damage assessment has been conducted (Ref. 23) in a large area, the State of Louisiana. However, that study stopped far short of anything so ambitious as an assessment of scavenging and stockpiling. Consequently, as part of this program a study has been initiated, but of a much smaller region, to attempt to evaluate the scavenging potential. For this effort, the region selected was located on the San Francisco Peninsula starting at South San Francisco and ending at the Sunnyvale-Santa Clara boundary. To further limit the magnitude of the task, thirteen industries were selected at the 3-digit level according to the Standard Industrial Classification (SIC) system of the Office of Management and Budget. These were picked because they were among those listed in Ref. 10 as critical to survival and recovery.

A catalog of industries located within the sample region provided geographical locations versus type of industry so that these could be plotted. However, these listings typically are disaggregated at the 4-digit level so that there were 24 different types of industry and 189 facilities represented. These fell in the following general categories:

> grain mill products; industrial inorganic chemicals; blast furnaces, steel works, and rolling and finishing mills; iron and steel foundries; primary smelting and refining of nonferrous metals; rolling, drawing, and extruding of nonferrous metals; engines and turbines; construction, mining, and materials handling machinery and equipment; communication equipment; electronic components and accessories; trucking, local and long distance; fixed facilities and services related to air transportation; radio and television broadcasting; and communication services.

To simplify the process, rather than plotting against street address, we cross-referenced each facility's SIC with its zip code, and mapped these accordingly. Locations were then compared with an attack scenario from TR-82. TR-82 is based on assessing the outcome of one possible attack strategy — considered to represent a full attack. It assumes an adversary would select potential targets from the following list:

- o U.S. military installations
- o Military-supporting industrial, transportation, and logistics facilities
- o Other basic industries and facilities making major contributions to the economy
- o Population concentrations of 50,000 or greater

The weapons laydown represents approximately 1,500 weapons totaling 6,500 megatons (Mt) in the range 1 Mt to 5 Mt and corresponding to 50% surface and 50% altitude bursts. Resulting overpressures (available on a two-minute grid) were

plotted for the sample area, and to simplify the task, these were also related to zip codes. This enabled us to establish what level of peak overpressure each facility "received" and relate it to type of industry (Figure 16).

The data base on the listed companies included size, in terms of number of employees. We made the arbitrary assumption that companies having five or fewer employees would be one group to become prime targets for scavenging (there would be others), so we sorted the data into two groups: more than five employees, and five or fewer employees. Exactly one-third of the 189 companies were in the fewer-than-five employee category. All the 189 companies, large and small, were sorted into three damage level groups according to overpressure received: greater than 20 psi, 10 to 20 psi, and less than 10 psi, and listed in Tables 16 and 17. There were no industries in overpressure regions below 2 psi (in host areas) where they might survive without hardening.

In both groups (large and small companies) about 30% were in overpressure regions above 20 psi where they would be very difficult to harden. About three fourths of the remainder of the large companies were in the 10 to 20 psi overpressure region where electronics equipment and semiconductor industries are somewhat difficult to harden, and half of the remaining smaller companies were also. SIC number 3674, semiconductor production, is the major manufactured product in the peninsula area. This industry is mostly located in zip code 94043, where the predicted overpressure is 10 to 20 psi. Of the 55 semiconductor manufacturers located in this area, 77% have more than five employees and 85% are predicted to receive less than 20 psi, while the smaller companies in the group account for 23% of the total, with 92% of them located in the same overpressure region where hardening could help them survive. As there are no plants in this industry group in the region that are located in host areas, recovery would involve considerable scavenging. Vulnerability, recovery, and scavenging potential all necessitate site visits if an assessment is to be made.

Fig. 16. Selected Critical Industry Locations Versus Overpressures.

Table 16

Predicted psi Levels of Critical Industries on the Peninsula With More Than Five Employees

SIC # (4 digit)	< 10 psi	10 - 20 psi	> 20 psi	TOTAL
2813 Industrial Gases			1 100%	1
3312 Blast Furnaces, Steel Works, and Rolling Mills			1 100%	1
3334 Primary Production of Aluminum			1 100%	1
3536 Hoists, Industrial Cranes, and Monorail Systems			1 100%	1
3537 Industrial Trucks, Tractors, Trailers, and Stackers			1 100%	1
3669 Radio and Television Transmitting, Signaling and Detection Equipment and Apparatus			1 100%	1
3671 Radio and Television Receiving Type Electron Tubes except Cathode Ray			1 100%	1
3339 Primary Smelting and Refining of Nonferrous Metals		1 33%	2 67%	3

SIC # (4 digit)	<10 psi	10 - 20 psi	>20 psi	TOTAL
3519 Internal Combustion Engines		1 33%	2 67%	3
4582 Airports		1 50%	1 50%	2
3673 Transmitting, Industrial, and Special Purpose Electron Tubes	1 25%		3 75%	4
2819 Industrial Inorganic Chemicals	1 50%		1 50%	2
3531 Construction Machinery and Equipment	1 50%		1 50%	2
3535 Conveyors and Conveying Equipment	1 50%		1 50%	2
4899 Communication Services	2 18%	4 37%	5 45%	11
2043 Cereal Break-Fast Foods		1 100%	0%	1
3316 Cold Rolled Steel Sheet, Strip and Bars		1 100%	0%	1
3674 Semiconductors and Related Devices	5 12%	32 74%	6 14%	43

SIC # (4 digit)	<10 psi	10 - 20 psi	>20 psi	TOTAL
3662 Radio and Television Transmitting, Signaling and Detection Equipment and Apparatus	3 17%	12 66%	3 17%	18
4832 Radio Broadcasting	2 50%	2 50%	0%	4
4833 Television Broadcasting	1 50%	1 50%	0%	2
3355 Aluminum Rolling and Drawing	2 100%		0%	2
3357 Drawing and Insulating of Nonferrous Wire	1 100%		0%	1

Table 17

Predicted psi Levels of Critical Industries on the Peninsula With Five or Fewer Employees

SIC # (4 digit)	<10 psi	10 - 20 psi	>20 psi	TOTAL
3312 Blast Furnaces, Steel Works, and Rolling Mills			1 100%	1
3532 Mining Machinery and Equipment except Oil Field Machinery and Equipment			1 100%	1
3534 Elevators and Moving Stairways			1 100%	1
3673 Transmitting, Industrial, and Special Purpose Electron Tubes			1 100%	1
3535 Conveyors and Conveying Equipment	1 25%	1 25%	2 50%	4
3339 Primary Smelting and Refining of Nonferrous Metals		1 100%	0%	1
3670 Electronic Components and Accessories		1 100%	0%	1
2819 Industrial Inorganic Chemicals	1 33%		2 67%	3

SIC # (4 digit)	<10 psi	10 - 20 psi	>20 psi	TOTAL
3531 Construction Machinery and Equipment	1 33%		2 67%	3
4899 Communication Services	4 50%	1 12%	3 38%	8
3662 Radio and Television Transmitting, Signaling and Detection Equipment and Apparatus	2 13%	11 74%	2 13%	15
3674 Semiconductors and Related Devices	5 42%	6 50%	1 8%	12
2812 Alkalies and Chlorine	1 50%		1 50%	2
4832 Radio Broadcasting	4 80%	1 20%	0%	5
3356 Rolling, Drawing and Extruding of Nonferrous Metals	1 100%		0%	1
3357 Drawing and Insulating of Nonferrous Metals	1 100%			1

Section 12
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Work completed in the second year of this five-year program has been directed towards: expanding guidance materials for industry to apply to reduce its vulnerability to disasters of any kind, maintaining rapport with industry through strong SSI participation in a local government/industry mutual aid group, initiating rapport with additional industries by developing contact with emergency personnel in other regions, pursuing the development of additional hardening options and testing these experimentally, simplifying hardening procedures, developing pictorial documentation of hardening implementations and outcomes, and initiating an assessment of scavengeable production resources.

With varying degrees, success has been achieved in all of the above areas. Most encouraging has been the success achieved in developing industry awareness and interest in nuclear attack preparedness through the strategy of integrating it with emergency management systems for other hazards. This is taking place not just at the individual plant level, but among industries, those that are members of the local mutual aid group with which SSI is working to provide a better integrated community response system. Unfortunately, there are few such organizations in existence on which to build this approach so that subsequent industry contacts may prove harder to develop. Perhaps, a deliberate attempt to establish more such groups could alleviate this problem.

The establishment of such mutual aid groups, generally, could also strengthen a national communications net for disaster use. The communications problem is seen as a major stumbling block in industrial postattack recovery unless some kind of dedicated communications system is established for industry to use. If a network could be established similar to that described in Section 3 as a goal for the local industry mutual aid group, then it would make good sense to establish a backup

communication satellite that could be committed to industry and kept available for postattack launch (as a means to ensure the system would function in time of need).

SSI has found an all-hazards clinic is an ideal vehicle through which to introduce nuclear attack preparedness relatively unobtrusively. However, the clinic approach to providing site-specific emergency preparedness advice to industries needs to be developed and evolved further to include additional emergencies such as tornadoes and hurricanes. It is recommended that more clinics be conducted to develop this vehicle into an effective tool, nationwide, to broaden industry awareness of the PIC program. When this is done through the expedient of providing valuable information regarding other, more frequent, emergencies (e.g., power outages, hazardous materials spills) in which industry already has major interests and concerns, industry response should increase significantly.

Proof testing of hardening methods, and documentation of industrial hardening as a credible response to be shown to industry decision makers, are very important facets of the ongoing program. The latter is a particularly important public relations type of effort that is desperately needed. These kinds of documentaries are very difficult to develop from field test documentation alone because operations cannot be conveniently "frozen" while specific scenes are staged; shock tunnel experiments could provide a convenient means to conduct this kind of photographic staging. (But, it would require some tunnel modifications to complete, e.g., to stage the loading on a below grade shelter structure, a pit would be required in the shock tunnel floor.)

In searching for utilities alternatives that industry might apply in an emergency, several areas were identified where program elements might profitably be developed. If industry is to have adequate process heat, a multifuel capability needs to be promoted so solid fuels can be burned, and an increase in engine generator installations is desirable because of the heavy demand for electricity to operate steam boilers, the major source of process heat. If conversions cannot be promoted, then stockpiling of conversion kits may be in order.

Among options that might be instituted postattack, in connection with industry

operations to provide process heat, recovery planners would most likely have to initiate action. As an example, the organization of process heat reuse by cascading higher quality waste heat to successively lower quality demand operations would probably require coordination of recovery planners. Potential domestic fuel supply options such as coal, distributed nationwide by water and rail transport, and combustible debris from cleanup operations, both feasible to institute postattack, would definitely require recovery planners to initiate action.

The transportation options that industry can implement unilaterally appear to be limited and already covered in the industrial protection guideline, or implemented by industry as a natural economic expedient. However, with regard to options that may involve joint responsibility between government and industry, industry may be able to contribute substantially to development of workable procedures that could be implemented quickly — provided the procedures and contingencies are developed in advance.

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APPENDIX A
EXCERPTS FROM HAZARD PLANNING MANUAL

APPENDIX A

The following text was extracted from material developed at SSI to help guide members of industry interested in analyzing plant facility vulnerability as they participated in a clinic conducted by a team of experts in disaster planning, analysis, preparedness, and response. To provide an example, material that covers two emergency situations, floods and power outage, is reproduced here. Both vulnerability analysis and countermeasures for nine emergency situations are covered in the complete manual at present, and several more (including tornadoes and hurricanes) are soon to be added.

TABLE OF CONTENTS

INTRODUCTION

HOW TO USE THIS MANUAL

Go through each vulnerability section and determine whether your risk is high (A), moderate (B), or very low (C). Then concentrate on those that are rated high first, skipping those rated "low" altogether; risks rated B also deserve attention. However, whatever your relative vulnerability, it will pay you to complete the form, cite the authority, and keep a permanent record of the rationale or authority for each of your decisions. Keep in mind that this **Manual** represents a short-cut method, which is not a substitute for the use of specialized expertise where required.

For those hazards where you have a high or moderate risk, you can then select countermeasures from the corresponding countermeasures catalog. Select those that may be applicable to your situation, feasible to do, and least expensive. Organize these in the order you intend to pursue them, and you will have the initial elements of an all-hazards plan, with an idea of cost, which tasks should be handled in-house, and which require public agency or outside consultant or vendor interaction.

Geographic Factor

The first step in assessing the vulnerability of a facility to various hazards is to consider the geographic factor of site location. Knowing nothing more than the location of a facility is sufficient to determine whether certain hazards are potentially present. It is neither efficient nor effective to worry about every conceivable disaster; your limited time and resources should be devoted to the more probable and serious hazards present at each of your facilities.

Some of the hazard categories can be initially rated by identifying risk zones in a general way on a small-scale, non-detailed map of the United States. Other hazards, such as flooding or hazardous materials, cannot be displayed at such a gross

scale. Flood hazard must be considered at a more detailed scale of map (generally, 1 inch = 3,000 ft), while the geographic component of hazardous material risk must be evaluated by reference to general descriptions of a particular building's location, neighbors, and environs.

Construction Factor

Some buildings and contents are highly resistant to particular natural hazards, others are not. This is considered under the heading of Construction Factor.

Organizational Factor

The nature of the organization must also be considered to achieve a comprehensive assessment of vulnerability. A hospital will be more vulnerable than a warehouse even if both face similar prospects of receiving damage.

Commentary is provided to indicate the underlying premises in the hazard ratings. The world is not actually so simple as to offer neatly delineated zones of risk or complete absence of risk, so various degrees of risk must be analyzed. In the approach here, a three-level ranking of risk is used for simplification and convenience, corresponding as much as possible to common perceptions of high, moderate, and low risk. For some facilities, special need may require more conservative evaluations of a hazard, and an added level of detail and higher threshold for the level of risk considered to be serious can be used. Keep in mind that this is a short-cut method intended to quickly focus attention on the most serious problesm and identify the most promising countermeasures.

EMERGENCY PLANNING FACT SHEET FLOODS

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Emergency Planning Lessons

1. Because floods occur relatively infrequently, inadequate attention is often paid to this hazard in many community disaster plans and on the part of individuals and companies. Flood losses in the U.S. average $2.2 billion annually and are projected to increase to $4.3 billion over the next 20 years, even though these floods are largely predictable.

2. There is a general reluctance on the part of residents to withdraw from areas threatened by flood waters. Regardless of sufficient warning time or official evacuation orders, the majority of people located within an affected area may be hesitant to leave. One technique found useful in educating the public ahead of time as to potential flooding is to post historic or predicted flood levels (painted high-water lines on public buildings, sign posts, etc.). An effective evacuation plan is more than just a map indicating transportation routes.

3. Although numerous shelters and evacuation centers are typically established to house flood victims, relatively few people use these facilities for their intended purpose. It is not uncommon, however, for evacuees to utilize public shelters for disaster-related purposes other than housing. Members of separated families, for example, typically seek one another in shelters. Similarly, evacuees housed elsewhere may visit public shelters in an effort to gather information.

4. Problems of post-emergency convergence are consistently observed in flood-stricken areas. For example, there is frequently an over-response on the part of volunteers to help with activities associated with disaster relief. Therefore, it is necessary for disaster planners to determine ahead of time the manner in which disaster volunteers will be organized.

5. Regular contact and communication in the pre-disaster period among those who must respond to such events will help to insure that essential resources will be easily mobilized. Police and fire departments, or private companies and public emergency service agencies, must interact much more extensively in a flood disaster than in the more usual, smaller scale emergency. In many cases it is not the lack of emergency resources but the lack of coordination of emergency resources that is the biggest problem.

6. Post-disaster recovery may require more coordination than the response to the emergency itself. Aid, insurance, permits, resource inventories, and other post-emergency tasks require advance planning to be efficiently coordinated.

Flood Zone Maps

To determine if a particular site is in a potential flooding area, the planning department of the local city (or county if in an unincorporated area) should be contacted. The Federal Insurance Administration can also provide maps: (800) 638-6620. Your insurance agent will have access to these same maps, and should be able to tell you if you are located in a flood-prone area, as well as provide information on flood insurance.

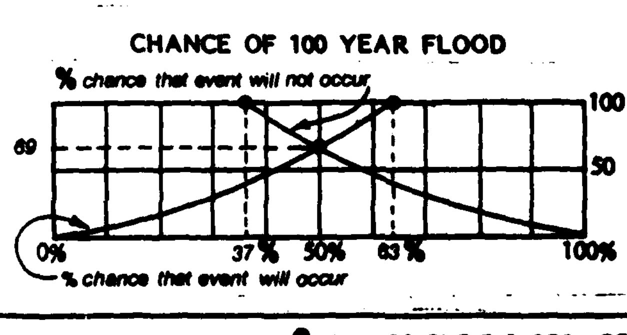
Contingency Planning Checklist

1. Consult flood maps.
2. Consult local officials in the emergency services (disaster services, civil defense) and planning departments.
3. Stockpile reasonable quantities of essential supplies; have a plan for quickly obtaining other resources if they become necessary.
4. Assume that electricity, telephone, and water service may be interrupted: If these outages would be unacceptably disruptive or unsafe, acquire generators, radios, and water tanks.
5. Know in advance how you would take advantage of the warning period (perhaps a day) that will probably be available: What preparedness measures would be taken if there is a greater than average chance of flooding because of continued heavy rains, if nearby lower areas begin to flood, if public officials announce that evacuation may be required, or if evacuations are ordered?
6. If evacuation is a possibility, consider relocation sites. Businesses may be able to operate essential functions from temporary facilities or from unflooded branch offices; families may stay with friends or at Red Cross shelters.
7. Itemize the most valuable or essential equipment or contents, and estimate how these items could be removed or raised up off the floor as high as possible. Copies of essential records—deeds, insurance policies, etc.—should be taken to another site.
8. Keep in mind that identification may be required to enter flooding areas, since law enforcement agencies will establish check points and cordons. Employees should have company ID cards, or small store owners should have a copy of a business license or other government record that identifies the name of the person and the address of the store. Generally drivers licenses are sufficient identification to enable residents to return to their homes.

The Hundred Year Flood

A 100-year flood is a flood which is estimated to occur on average once every 100 years, and the chance that it would occur in any one year is one in a hundred or 1%. There is no meteoriological reason to prevent more than one 100-year flood from occurring in 100 years, just as there is nothing to prevent one from flipping a coin and having it land on the heads side several times in a row even though the average over a large number of tosses will be one heads out of two. Due to the statistical laws involved, there is a 63% chance that the 100-year flood will occur in 100 years.

CHANCE OF 100 YEAR FLOOD



Sandbags

Sandbag barriers are not watertight, but they are usually adequate as emergency flood barriers. Sandbags are fabric sacks which are usually filled with sand or soil at the site where they are to be used (rather than delivered pre-filled). Sacks approximately 18 to 24 inches long and 12 to 18 inches wide are available from burlap sack manufacturers, or rural hardware and farm supply stores. A local office of the U.S. Army Corps of Engineers, or a local public works department, may be able to suggest where sacks can be purchased. Locating a local source of supply and stockpiling a reasonable number of sacks for the flooding anticipated is recommended: The cost is small, the storage space is minimal, and otherwise there may be no sacks available when they are required.

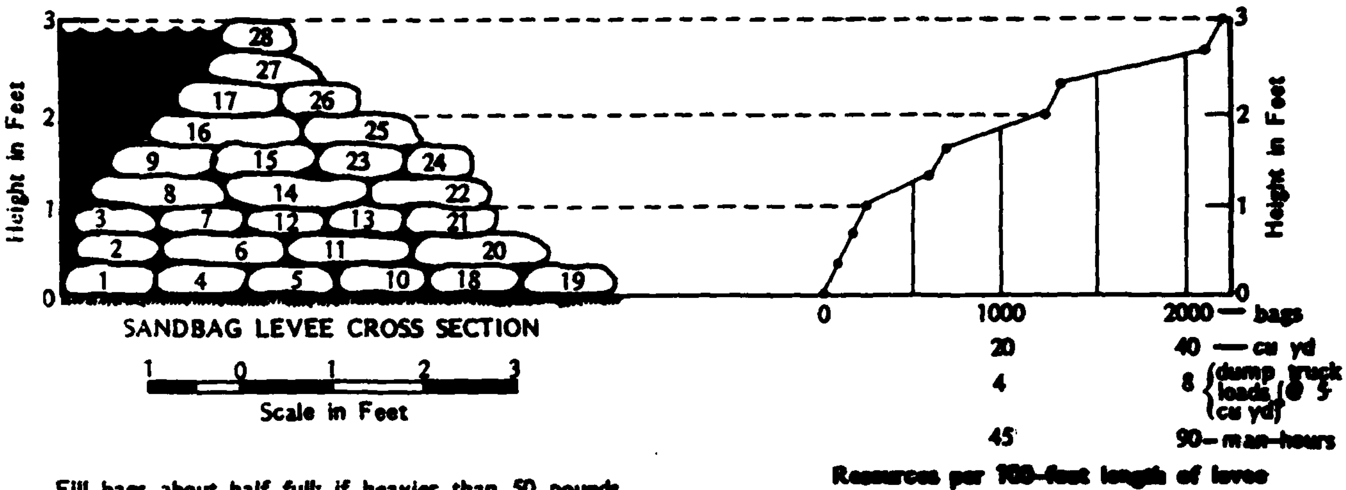
A stable wall three layers high can be formed a single sack in width; above this height, a pyramid shape is recommended. See the diagram below, which is based on information from the U.S. Army Corps of Engineers.

Pumps

Pumps are useful equipment for dealing with flood waters where the flooding is localized (as in a basement) rather than extensive (as when an entire valley is inundated).

Pumps can be purchased for less than $500, or rented from equipment rental companies. Muddy or debris-filled water requires the use of pumps that will not clog, such as trash pumps or diaphragm pumps. Electrically powered pumps must be used according to the manufacturer's directions to avoid electric shock. Combustion engine pumps are less hazardous. Common capacities range from about 50 gallons per minute to about 350 gallons per minute; the smaller size would pump enough water to drain an average residential swimming pool-size quantity of water in about 12 hours, while the larger size would pump this quantity in less than 2 hours.

Fire engines (pumpers) are high-powered pumps, but they may not be available for flood-related tasks.



Fill bags about half full; if heavier than 50 pounds, they will be difficult to place. Leave enough room to fold under end flaps as they are placed. Numbers on bags indicate most efficient placing sequence: first put a one-foot high single-width wall in place. Stamp each bag firmly in place to increase the water resistance of joints.

Related Hazards

Flooding may be caused by precipitation (which is discussed here) or by dam failure, tsunami (seismic sea wave), or hurricane storm surge.

Mudslides and landslides may be caused when soils become saturated with water, and in many areas these potential hazards have been mapped and can be located through the similar sources of information for flood maps. Electrical shock is a major hazard when water is present, and hence the power should be turned off in flooded buildings, and the special electrical safety warnings offered here in the section on pumps should be followed. Ironically, there may be a water shortage during and following floods, since reservoirs become filled with muddy water. For small quantities of water, the plastic bottles of water found in grocery stores are convenient, the cost is small (50 cents to a dollar a gallon), and the antiseptic precautions required to fill and store your own containers of water are avoided.

Sources of Information

Natural Hazards Research & Applications Information Center, I.B.S. #6, Campus Box 482, University of Colorado, Boulder, CO, 80309, (303) 492-6818. The Center's quarterly newsletter, The Natural Hazards Observer, is available free of charge.

U.S. Water Resources Council, 2120 L Street, N.W., Suite 800, Washington, D.C., 20037, (202) 254-6453. Several reports are available from the Council, including Cooperative Flood Loss Reduction, Floodplain Management Handbook, and Regulation of Flood Hazard Areas to Reduce Losses.

American Institute of Architects Research Corporation, 1735 New York Ave., N.W., Washington, D.C. 20006, (202) 626-7421. A report on Design Guidelines for Flood Damage Reduction is available that outlines architectural and engineering techniques for decreasing flood damage.

Federal Insurance Administration, Federal Emergency Management Agency, Washington, D.C., (800) 638-662[illegible]. Information can be provided on flood insurance maps, coverage, and rates. It is generally easier to first contact your insurance broker for this same type of information, since flood insurance is Federally supported but sold through private insurers.

Background

Industrial buildings and their contents are especially vulnerable to flooding because industrial areas in many communities occupy lowlands nearest major streams. Industry thus is the first flooded and the last to be free of flooding. In addition to large buildings, industrial plants contain expensive machinery and valuable stockpiles of raw materials and finished products, which are subject to the risk of loss.

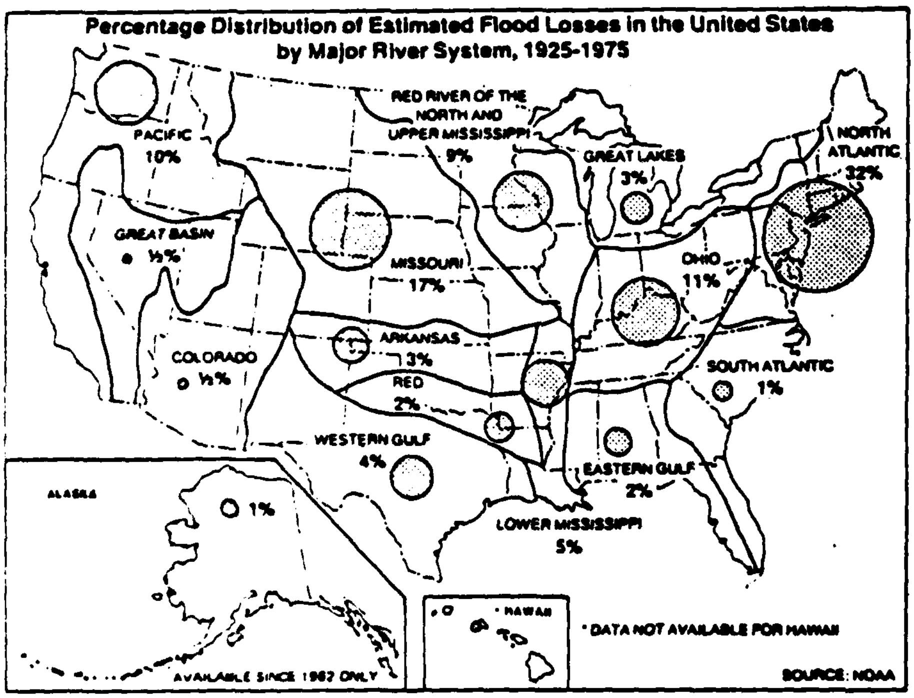
Types of Floods

- o Coastal flooding (along oceans and lakes)
- o Flash flooding (small watersheds)
- o River flooding (large watersheds)
- o Sheet flooding (rainfall or snowmelt over flat, poorly drained areas)

Flood Losses

Seventy-five percent of all presidential disaster declarations during the 1970's were due to flood losses.

Flood losses are not distributed uniformly across the nation. Some areas have flood problems significantly greater than others. But no region or state is totally immune to flooding, including the normally dry deserts of the Southwest. Figure 1 shows the distribution by region of flood losses for the 50-year period ending in 1975.



Totals may not add to 100% due to rounding

FIGURE 1. NATIONAL FLOOD LOSSES

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continued

Economic losses to industry from floods include direct damages, indirect damages, and other costs.

Direct damages are due to the force of flood waters or to inundation. They include:
- o Destruction of roads, bridges, and utility systems
- o Collapse or flotation of industrial structures
- o Loss of legal, financial, and other documents and records
- o Damage to or destruction of furniture, fixtures, appliances, machinery, and other building contents
- o Silt and erosion deposits

Indirect damages results from the secondary effects of direct damages. Examples are:
- o Losses or damage due to disruption of services (e.g., electric, water, gas, highway, bridges)
- o Fire and explosion due to inundation of electrical and gas systems

Other costs that are identifiable expenses associated with flooding include those for:
- o Evacuation and reoccupation
- o Care of evacuees
- o Debris removal and cleanup
- o Business interruptions and lost labor
- o Interest on rehabilitation loans

There are also unmeasurable economic costs due to flooding. These intangible costs include such things as reductions in property value and the diversion of effort from regular activities.

Flood Impacts on Industry

Floods have short- and long-term fiscal impacts on industries. In the short term, interruption of production often means an immediate loss in sales, and the inability to fulfill orders on a timely basis may lead to a decrease in a firm's market share. In the long term, the "ripple effect" increases unemployment in the community, beyond the industry that is directly affected.

Site Specific Flood Protection Countermeasures

Owners and operators of industrial property subject to flooding should not depend on others for protection. There are numerous means of protecting property that can be carried out on an individual plant basis. These protective countermeasures are listed in the Flood Countermeasures section

Site Vulnerability Assessment

1. Flood Maps

Consult a Federal Insurance Administration Flood Insurance Rate Map. These are available from local insurance agents or mortgage lenders, or call (800) 638-6620 to request a map for a particular city. City and county planning or public works departments may also have their own flood hazard maps.

Indicate the flood zone pertaining to the site, as shown on the Flood Insurance Rate Map. Record map name, number, and date:

____.

Identify your facility location on the map and determine if you are in zone A, B, or C:

____ Flood zone C: little or no flooding; no other consideration of flood hazard for this site is required, except for step 3 below relating to dam failure.

____ Flood zone B: there is approximately a 0.2% (1 in 500) annual chance of flooding. The flood hazard of the site is MODERATE. Continue with the following steps and consider the flood countermeasure options contained in Section 2.

____ Flood zones with A designation (A, AO, AH, etc.) or V (V, V1-V3D, V0): flooding has approximately a 1% annual chance of occurrence. Flood hazard is HIGH. Continue to the following steps and then consider the flood countermeasure options contained in Section 2.

2. Flood Depth

Determine the expected depth of flood water relative to the facility. Generally the most important facility elevation to consider is that of the ground floor, though access roads, tanks, electrical equipment, and other exterior site improvements may be a consideration as well. The elevation(s) of the facility will then be compared with the expected flood water elevations, as shown on the Flood Insurance Rate Map or other map. To determine the facility's elevation:

____ Consult the construction drawings ("blueprints") used in the construction of the building. Floor or site elevations may not be in terms of elevation above sea level (which is used for the flood maps) but rather keyed to an arbitrary zero point, in which case the height of a ground floor, for example, must be converted to elevation above sea level.

____ Consult standard U.S. Geological Survey (USGS) topographic map (7½ minute quadrangle" describes the typical size of area covered) to determine exact elevation of points on the site from the elevation contours on the map. Then determine the additional height above the ground of the desired point in the facility, such as the ground floor. USGS maps of local areas are widely sold in map stores, science supply shops, or outdoor recreation supply stores. In addition to regional USGS offices, maps can be ordered from the U.S. Geological Survey, Denver, CO 80225. Index maps of states are free and indicate the name of the specific quadrangle that will include the area of interest.

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___ Check with the local public works department to see if they can provide the elevation of a known point on or near the site, such as a street intersection.

flood water level - facility level = depth of flood water

3. Dam Failure Flooding

Is the site subject to inundation (flooding) in the event of the failure of a dam? Local planning departments or emergency services offices may have copies of dam failure inundation maps. In California, these have been prepared for all significant dams. Record which of the following pertains:

___ The site is not within a dam failure inundation area; no further consideration of this type of flooding is required. Skip to last page of this section and indicate information source.

___ No reservoir exists uphill of the site within 20 miles; no further consideration of this type of flooding is required.

___ The site is within a dam failure inundation area, as shown on:

____

Indicate any other information available on the potential inundation, such as:

_______ approximate depth of flood waters

_______ approximate time for water to reach site

and continue to step 4 below.

4. Dam Safety

A dam failure inundation map indicates that if a dam fails, then water will reach certain areas, but it does not mean that the failure of a dam is necessarily likely or even remotely possible. To include consideration of the safety of a particular dam, the safety ratings of the National Dam Inspection program may be used, and dams not considered unsafe according to this rating system may be assumed to be safe. But if the dam is not known to be rated as unsafe:

_______ dam is listed as unsafe ("   ") according to:

____

_______ dam is not listed as safe ("   ") according to:

____

5. **Summary**

Summarize by category the type of flooding expected:

___ Broad, flat flood plain, where water would rise slowly over a wide area. Countermeasures that take more than a day to implement during an emergency period may be feasible. Widespread flooding will disrupt transportation, utility service, etc., throughout the area.

___ Narrow river valley or areas adjacent to mountains, where water might be rapidly moving, such as flash flooding. The warning time may be less. The flooding may be more localized, so that nearby areas will be undamaged and evacuation of items only a short distance away may be feasible. Structural damage caused by moving water and debris a greater hazard.

___ Dam failure with warning time reduced to minutes. Structural damage caused by moving water and debris may reach its most severe intensity for this type of flooding.

___ Coastal area or area adjacent to large lake or bay where tides and waves may be present. Proximity to a body of water is an extra hazard. Time of high tides will be significant in determining maximum flood heights. (For hurricane coastal flooding, see separate hurricane section.)

___ (Tsunami or seismic sea wave hazards are considered separately under EARTHQUAKES.)

--- (Mudslides are considered separately under SOILS FAILURES.)

These construction considerations are applicable only to structures on sites with B or A (moderate or high) site vulnerabilities for flooding, as determined in the preceding subsection.

_____C: Low construction vulnerability

____ Exterior materials are concrete, masonry, or metal, either exposed or covered with tile or stucco; (wood frame with stucco exterior excepted).

____ Door and window openings and walls are not waterproof, and if water enters building to height of expected flooding, only materials listed above will get wet; equipment is located above flood level, or could be quickly elevated.

____ Doors and windows are either above flood water elevation, are waterproof when closed, or can be quickly made waterproof; (glass should be presumed to break if below the expected water level and if not protected with plywood).

_____B: Moderate construction vulnerability: Facility does not completely qualify for the category C above; surfaces expected to become wet do not include sheetrock, fiberglass insulated walls, expensively carpeted floors, or wood frame walls or floors.

_____A: High construction vulnerability: Wood walls or floors, fiberglass insulation, sheetrock, expensive carpet; valuable or essential equipment located below flood level and could not be quickly moved.

Organizational Vulnerability Assessment

In addition to the location of a facility and its construction characteristics, it is important to consider the variation in vulnerability presented by differences in types of operations.

_____C: Low organizational vulnerability. Organization could withstand a one-week shutdown due to service outages or flood damage without experiencing a major follow-on loss and without jeopardizing an essential function. Some smaller businesses without extensive overhead or workforces may fall into this category. Organizations whose functions could be temporarily met without relying on a functional building would also qualify.

_____B: Moderate organizational vulnerability. Up to one day of shutdown would be tolerable. Many large companies would fall into this category; although any shutdown would be costly, there would be no major continuing aftereffects, such as damage caused by interruption of continuous operating industrial processes, loss of markets, missing of deadlines.

_____A: High organizational vulnerability. Even one day of disruption would create major problems. Essential facilities such as hospitals, police stations, utility facilities, or banks would be typical examples falling within this category, as well as any company providing a service or operating on a production schedule with no tolerance for a one-day closure.

Overall Vulnerability Assessment

To combine the site, construction, and operational vulnerability assessments into an overall assessment, use the tables below. A combined vulnerability rating is useful for purposes of ranking relative importance.

Enter the site, construction, organization, and overall flood vulnerability rating letters on the all-hazard summary sheet at the end of the **Manual**.

Site Vulnerability A:

		ORGANIZATION A	ORGANIZATION B	ORGANIZATION C
CONSTRUCTION	A	A	A	A
CONSTRUCTION	B	A	A	B
CONSTRUCTION	C	A	B	B

Site Vulnerability B:

		ORGANIZATION A	ORGANIZATION B	ORGANIZATION C
CONSTRUCTION	A	A	A	B
CONSTRUCTION	B	A	B	B
CONSTRUCTION	C	B	B	B

Site Vulnerability C:

Because chance of flooding at the site is so remote, no consideration of construction and organizational characteristics was necessary; overall vulnerability is C. (See item 3 for information source.)

EMERGENCY PLANNING FACT SHEET— INDUSTRIAL

POWER OUTAGE

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Outage Risk

Short term power outages, lasting minutes to days, can occur as an outgrowth of any major areawide disaster (flood, ice storm, hurricane, earthquake, tornado, etc.) that may affect one or more entire utility generation and distribution systems. Short term outages can also occur as a local phenomenon, lasting from minutes to hours, as a result of a minor neighborhood incident (construction or aircraft accident, lightning bolt, fire, explosion, act of vandalism) that knocks out a power line, substation, transformer, switchgear, etc. Long term power outages, measured in days or weeks — would likely culminate in rotating blackouts and could result from international political or economic decisions, or an event such as TMI. As there is no clear cut basis for tying power outages to well documented (statistically based) risks alone (e.g., natural disasters), risk assessment is best established in terms of emergency shutdown costs. Such costs are likely to be highest when sudden loss of power is especially critical to some processes, for example if it would completely ruin the product run, damage production equipment (or even, perhaps, become extremely dangerous, should substances become unstable without power for automatic process operation and control of cooling, heating, adding of inhibitors, etc.). From power outage studies conducted by the Electric Power Research Institute, about 10% of the companies caught in a sudden power outage could have justified an onsite standby system based on lower total cost than the product and equipment losses suffered. Half of these companies needed standby capacity nearly equal to total demand, while the other half needed only enough standby capacity to run a small fraction of their operation that had a critical demand for power. It is not surprising that the latter group already had standby systems onsite and ready.

To determine if your plant (or division) should consider a standby system, you need to conduct an emergency shutdown analysis and assess the safety aspects and economic impact of a sudden power outage. Clearly, if a **small portion** of your operation cannot stand a sudden shutdown without a high penalty cost, then there is a fair likelihood a standby generator will be easily justified. If **most** of your operation cannot stand to be shut down suddenly without causing a high penalty cost, there may still be a possibility that standby power is justified. If **all** operations can be shut down at any time without warning and with no effect other than minor annoyance and temporary cessation of operations, you don't have a serious risk from power outage — excepting that you may have a serious personnel safety problem with sudden loss of lighting, depending on whether operations are conducted at night, in windowless buildings, or under any other conditions where artificial lighting is required for safe exit from the workplace. In such instance, at least a battery powered continuously charging backup lighting system would be required as an emergency measure.

Outage Considerations

Power outage is not the only reason to consider onsite power generation capability. A variety of incentives has appeared since the first energy crisis surfaced to make consideration of onsite generation worthwhile. When there is a combined demand for electricity and process heat or when fuels are available that are particularly inexpensive (e.g., solid wastes or natural stream flow), onsite systems could save you money, slow the growth of your energy costs, and provide protection against curtailment, international incidents or rotating blackouts. Moreover, if you require significant quantitites of both electricity and process heat, you might want to consider the combined benefits of emergency preparedness and greater efficiency obtainable with cogeneration systems. Where onsite power generation is used in conjunction with utility supplied power, the onsite system could also supply additional power for short periods in emergencies because most generating units can operate for several hours at considerably more than rated output (long enough for most utility power outages). Likewise, the utility supplied power could be increased in an emergency involving failure of the onsite system.

Fairly recent regulations affecting utilities make it easier to do some this. Under PURPA (the Public Utility Regulatory Policies Act of 1978), utilities are required to take actions that will encourage energy conservation (among other things). As an example of what might be accomplished, in northern California the Pacific Gas & Electric Co. will pay a flat annual premium of $10,000 to any industry with a 100 kW generator (or larger) that will agree to operate its onsite generator continuously to supply all or part of the onsite power demand in the summer, when the utility has heavy demand. This arrangement combines industrial energy conservation, emergency standby power, or both, with load-leveling at the utility to provide economic benefits to both parties. This is a **negotiated industry/utility joint saving.** Similar possibilities may exist in your area — so find out what your utility is doing under PURPA! As an added incentive, PG&E provides a guarantee that, while such standby units are operating under contract, power costs will not be any greater than had the onsite power been purchased from the utility.

Some industries have paid special attention to producing power onsite by means of fuels that are not likely to be interrupted by an international incident (such as happened in Iran) and seek to develop opportunities using low head hydro power or cogeneration based on burning locally available solid fuels. As a result of the energy crisis of the early 1970's, there are many more opportunities today for a company to make itself less vulnerable to the increased risk of power interruption, for any reason, and to realize dollar savings in the bargain. Two matrices have been provided with this factsheet to help you identify some of the options and tradeoffs — you might also benefit by a discussion with your local utility representative.

TECHNOLOGY	BENEFITS	DRAWBACKS
STEAM TURBINE	Long Life; Can Burn Coal, Solid Wastes	Low Efficiency; Less than 10 MW Uneconomical
GAS TURBINE	High Temp. Heat; One to 10 MW OK; Efficiency OK	Petroleum-based Fuels Only
DIESEL ENGINE	High Efficiency; Sizes down to 100 kW OK	Low Waste Heat Petroleum Fuels Required

INDUSTRIAL ONSITE POWER ALTERNATIVES

ALTERNATIVES	TYPE SERVICE	AVAILABLE SIZE RANGE (KW)	GEOGRAPHICAL CONSTRAINTS	CONSIDERATION & PROBLEMS	COST $/KW AT KW SIZE	INCENTIVES [1]	IMPLEMENTATION LEAD TIME	FUEL SUPPLY TYPE &	FUEL SUPPLY VULNERABILITY TO CUTOFF	EQUIPMENT DISASTER VULNERABILITY
COGENERATION	RELIABLE EVERYDAY	50 TO 500,000 (PRACTICAL RANGE)	NONE	NEED PROCESS HEAT DEMAND > 53,000 LB/HR (STEAM), ENVIRONMENTAL ISSUES		FEDERAL (INVESTMENT TAX, OCCASIONAL ENERGY TAX) PLUS LOCAL STATE & UTILITY PROGRAMS	2 YEARS MINIMUM TO OVER 5 YEARS [2]	LIQUID GAS SOLID	SEVERE HEAVY TO MODERATE MODERATE TO LIGHT	SIZE AND LOCATION DEPENDENT SHOULD BE INSTALLED IN HARDENED OR HARDENABLE STRUCTURES
RANKINE TOPPING		50 TO 15,000			175 AT 50 110 AT 15,000					
INTERNAL COMBUSTION		150 TO 25,000			600 AT 150 800 AT 1,300					
RANKINE BOTTOMING		500 TO 15,000			710 AT 500 490 AT 15,000					
GAS COMBUSTION (TURBINE)		500 TO 100,000			400 AT 500 500 AT 18,000					
RECIPROCATING STEAM		5 TO 5,000			580 AT 1,000 220 AT 5,000					
COMBINED CYCLE		1000 TO 150,000			440 AT 2,500 390 AT 20,000					
FUEL CELLS		15 TO 5,000			544 AT 5,000 TO 25,000					
HYDRO	RELIABLE EVERYDAY [2]	200 TO 15,000	HEAVY LOCAL, STREAM SITE	NEED RIVER & RIGHTS	1,000 TO 2,000 AT 5,000	•	~ 2 YRS RUN OF THE RIVER 6-7 YRS OTHERWISE	WATER FLOW	LIGHT TO NIL	VERY LOW
WIND	SPORADIC [3] EVERYDAY	100 TO 2,000	MODERATE, REGIONAL	MINIMUM WIND 8-10 MPH MAXIMUM WIND 20-30 MPH STORAGE LIMITED	1,000 TO 3,000 AT 2 TO 10	•	> 3 YEARS	AIR FLOW	NONE	LOW
GEOTHERMAL	RELIABLE, EVERYDAY	50,000 TO 100,000	SEVERE REGIONAL	NEED WATER AND MINERAL RIGHTS	UNKNOWN	UNKNOWN	> 3 YEARS	GEOTHERMAL	NIL	VERY LOW
STANDBY ENGINE GENERATOR	PERIODIC NONSTEADY EMERGENCIES	5 TO 10,000	NONE	ENVIRONMENTAL ISSUES	PER SET (1980) GASOLINE: 0-5 KW $491; 5.1-15 KW $1,574; 15.1-35 KW $2,950; 35.1-100 KW $7,587; 100.1 → $44,578 DIESEL: 14 KW $3,473; 14.1-50 KW $7,350; 50.1-100 KW $12,896; 100.1-200 KW $16,603; 200.1-400 KW $28,447; 400.1-1000 KW $62,716; 1000.1 → $330,447	INVESTMENT TAX PLUS LOCAL UTILITY	1-7 DAYS RENTAL 2-10 WK. PURCHASE	LIQUID GAS	SEVERE HEAVY	HARDEN
CONVERTED INDUCTION MOTOR	EMERGENCY ONLY	1 TO 300	NONE	NEED CONVERSION KIT, PRIME MOVER SPARE MOTOR	UNKNOWN	NONE	1-2 DAYS WITH CONVERSION KIT	DEPENDS ON PRIME MOVER	HEAVY TO SEVERE	HARDEN

1/ FOR UNITS OVER A CERTAIN SIZE, CALIFORNIA UTILITY PROGRAMS OFFER GUARANTEED POWER COST PLUS $10,000 ANNUALLY TO STAY "OFF-LINE" DURING PEAK DEMAND SEASON
2/ MINIMUM TIME FOR SMALL UNITS AND WASTE HEAT UNITS, LONGER TIMES ARE FOR LARGE SYSTEMS
3/ SUBJECT TO SEASONAL INTERRUPTION ON SOME STREAMS
4/ SUBJECT TO DAILY INTERRUPTION

Power Outage Vulnerability Assessment

1. Examine your plant emergency-shutdown plan, routine, or records, and determine how long a complete shutdown takes to execute.

____ C No warning time necessary, just turn everything off.

____ B Some warning time necessary to avoid small financial loss.

____ A Warning time critical to safety or to avoid significant loss.

2. Use the Emergency Shutdown flow chart to identify where specific problems may develop as a result of sudden shutdown from a power outage. (Power outage may not be the only utility failure that could necessitate shutdown, ruptured gas, water, or communications lines might also — with different problems resulting than indicated in the flow chart presented. You might want to look at your vulnerability to these, also.)

3. Estimate the damage likely to occur for each specific problem that emergency shutdown could cause. You will need to determine the time required for repair, the cost to complete repairs or replacement, the production and salary losses that would be suffered, and any other cost incurred.

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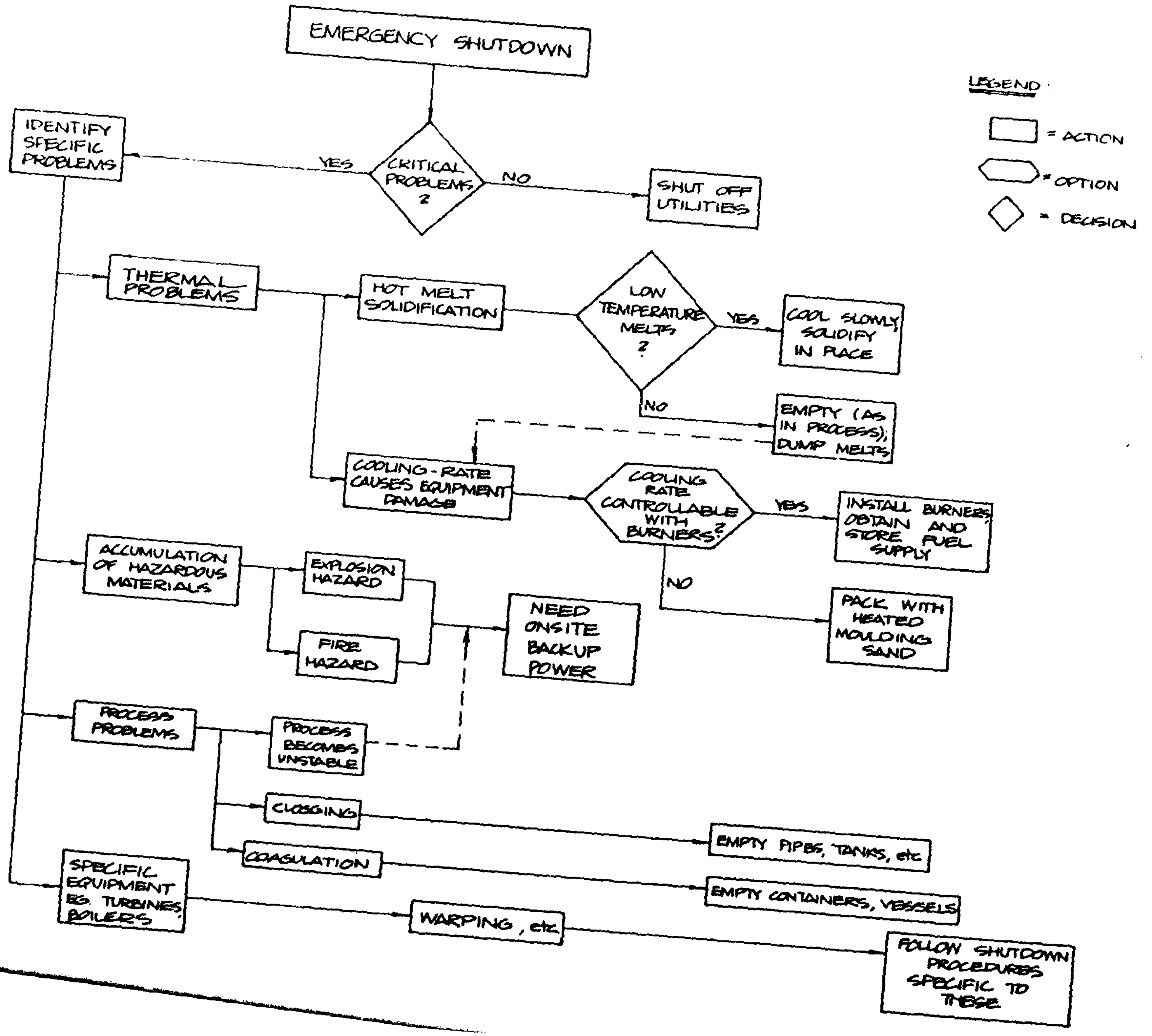

EMERGENCY SHUTDOWN
CRITICAL PROBLEMS ?
YES
NO
IDENTIFY SPECIFIC PROBLEMS
SHUT OFF UTILITIES
THERMAL PROBLEMS
HOT MELT SOLIDIFICATION
LOW TEMPERATURE MELTS ?
YES
COOL SLOWLY, SOLIDIFY IN PLACE
NO
EMPTY (AS IN PROCESS); DUMP MELTS
COOLING-RATE CAUSES EQUIPMENT DAMAGE
COOLING RATE CONTROLLABLE WITH BURNERS?
YES
INSTALL BURNERS; OBTAIN AND STORE FUEL SUPPLY
NO
PACK WITH HEATED MOULDING SAND
ACCUMULATION OF HAZARDOUS MATERIALS
EXPLOSION HAZARD
FIRE HAZARD
NEED ONSITE BACKUP POWER
PROCESS PROBLEMS
PROCESS BECOMES UNSTABLE
CLOGGING
EMPTY PIPES, TANKS, etc
COAGULATION
EMPTY CONTAINERS, VESSELS
SPECIFIC EQUIPMENT EG. TURBINES, BOILERS
WARPING, etc
FOLLOW SHUTDOWN PROCEDURES SPECIFIC TO THESE
LEGEND:
= ACTION
= OPTION
= DECISION

Power Outage Checklist

___ C: No power outage problem; but review whenever there is a facility or production change
___ B: Minor power outage problem
___ A: Major power outage problem; review of countermeasure options recommended

There is really only one countermeasure to a power outage when power is critical — an alternative supply. Whatever variation is to be found in countermeasures come about from variations in specifics of application, size of demand, and strategies for integrating emergency onsite needs with regular production needs. There are too many variables to develop a generic selection process for an onsite power system, but a checklist of some vital applications to consider in developing a preliminary analysis for further discussion should include:

Safety
- Emergency lighting
- Life support
- Elevators in high rise structures
- Pumps and controls for:
  - Fire suppression equipment
  - Maintenance of chemical stability in process
- Emergency communications
- Refrigeration systems required to keep foods or chemicals stable

Economic
- Production loss limitation
- Equipment loss limitation
- Paid man-hour loss limitation
- Customer loss limitation
- Peak load reduction to limit penalty charges
- Cogeneration benefits of lower total energy cost

Today, utilities are much more willing to help customers reduce energy demand as part of a program to reduce their own costs for new capital equipment. In many cases utilities are quite willing to provide information and help their industrial customers make analyses that could lead to implementation of alternative generating systems. However, the first step must be taken by the customer, to identify critical needs and possible alternative options, before entering serious discussions with consultants and utilities. The material on power outage here and in the countermeasures section will provide a basis for a preliminary analysis of the problem to assess feasibility and practicality of further pursuit.

All-Hazard Vulnerability Summary

HAZARD	SITE	CONST.	ORG.	OVERALL
Floods				
Earthquakes				
Soils failures				
Nuclear				
Fire				
Hazardous materials				
Bomb threats				
Tornadoes				
Hurricanes				
Winter storms				

A = HIGH vulnerability
B = MODERATE vulnerability
C = LOW vulnerability

FLOOD COUNTERMEASURES

Flood Countermeasure 1: Flood protection engineering

Generally, civil engineers are the experts most involved with flood protection engineering projects, such as the design of storm drainage systems, dikes, channels, or culverts (which are pipes that pass beneath roads). Meteorologists are obviously also important to the overall process, but they are generally not involved as consultants for individual projects. Architects may be involved in flood-related problems as they affect the site planning and design of a facility; they typically rely on consulting civil engineers for the detailed design of flood-protection works.

Civil engineers are licensed by the states. Civil engineering also includes many non-flood related fields, such as roads, airports, ports, bridges, and building structural analysis, and therefore not all civil engineers engage in flood protection engineering.

How to proceed, sources of information: Civil engineers are listed under "engineers" in the Yellow Pages.

Flood Countermeasure 2: Pumps.

Pumps are useful equipment for dealing with flood water where the flooding is localized (as when a basement or the area behind a sandbag barrier floods) rather than extensive (as when an entire flood plain fills with water).

Power source: Combustion engine pumps are preferable to electrical pumps for flood purposes. Electrical service may be interrupted, electrocution can result if errors are made in the use of the pump, and there is less mobility because electrical pumps must be plugged in. Permanently installed electric pumps, however (such as the ordinary swimming pool pump), may be adaptable for flood applications.

Pump types: There are a number of types of pumps, but the two that are best suited to the common flood situation of pumping water that contains mud, stones, or debris are the diaphragm and "trash" pump, designed for use in farm irrigation, drainage of excavation by contractors, pumping sewage, etc. Diaphragm pumps are limited to lifting water about a maximum of 25 feet above the level of the pump; trash pumps are usually centrifugal (fan-type) in action and can lift to greater heights.

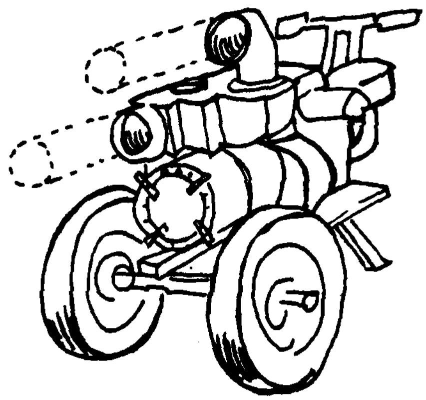
Flow rates: Usually specified in gallons per minute (GPM), which indicates the volume of water pumped. Common flow rates for medium size movable pumps vary from 50 to 350 GPM. The lesser rate is sufficient to pump the quantity of water in a normal residential swimming pool in about 12 hours, while the greater rate pumps this quantity in less than 2 hours. Flow rates go down as the water is lifted to greater heights above the pump.

Suction lift: The height to which water can be lifted by air pressure alone, using the principle of a vacuum. The theoretical maximum at sea level is about 34 feet, with about 25 feet of lift being a practical limit. Diaphragm pumps are limited by suction lift.

Pressure: The uniform force exerted by the fluid as a result of being compressed by the pump, expressed in pounds per square inch (psi). For water, the pressure in psi multiplied by 2.31 equals the head (see below) in feet. Ordinary pumps operate at less than 100 psi; ordinary water pressure out of a building's plumbing is usually about 50 psi. Higher pressure means that the pump can lift water to a greater height.

Head: A measure of pressure expressed as the height in feet of a column of water that can be lifted by the pump. The head produced by a pump indicates its ability to pump to a higher level. To drain a basement, the elevation change from the bottom of the basement to the point where the pump discharges would be the head required. Head, in feet, divided by 2.31 equals the pressure in psi.

Cost: For small portable pumps, of 50-500 GPM capacity, about $200-$1000.



Example: A portable centrifugal type trash pump capable of pumping about 375 GPM of water at 10 feet of head, through a 3-inch diameter hose, powered by a gasoline engine. Cost: about $800.

Other applications: Pumps may be useful for de-watering excavations, draining water off flat roofs with clogged drains, removing water from poorly drained areas of parking lots or basement garages in normal rains, or firefighting. Pumps used in the normal operation of other equipment (industrial processes, pools, tall building plumbing systems, fire engines, fire sprinkler systems) may be adaptable to emergency use for floods.

How to proceed, sources of information: "Pumps" are listed in the Yellow Pages. Large industrial supply catalogs typically have a section devoted to pumps. For rental pumps, check with contractors equipment rental companies. Most large industrial facilities already have one or more pumps on hand, so a check of existing equipment should first be made.

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Flood Countermeasure 3: Sandbags

See blue-colored Flood Emergency Planning Fact Sheet.

Flood Countermeasure 4: Obtaining accurate information on the progression of a flood during a storm.

During a slowly developing flood, up-to-date information can help indicate how immediate the flood hazard is for a given site. The elevation of a facility should be accurately known (see the flood site vulnerability worksheet in Section 1, step 2), as well as the exact names of nearby stream channels, dikes, bridges, etc. Information on the present or predicted elevation of flood waters available from public authorities can then be quickly related to the amount of "freeboard" or height above water level at a given facility.

Sources of information include:

___In California, the following California Department of Water Resources telephone numbers:

___(916) 445-7571: 24-hour recording; tide times and heights, flood conditions.

___(916) 322-3327: 24-hour recording; stream flow figures, flood conditions.

___(916) 445-3553: 24-hour state flood operations office number.

___local emergency services office:

___state emergency services office:

___National Weather Service broadcasts.

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Flood Countermeasure 5: Flood protection of storage tanks

This countermeasure applies only to tanks located in flood-prone areas (see the flood vulnerability rating subsection in Section 1). This countermeasure is especially applicable to tanks containing hazardous materials.

Federal OSHA General Industry Standards, 1910.106 (b) (5) vii, contain flood protection requirements for tanks containing combustible or flammable liquids. The OSHA regulations cover such topics as systems for adding water to water-compatible materials in tanks to keep the tanks from floating, design criteria for structural guides to keep floating tanks from being moved laterally, design criteria for the anchorage of tanks to keep them from floating or moving laterally, types of valves and pipes required, and posting of instructions on flood response procedures.

Anchorage of tanks may be accomplished by attachment of a tank to a foundation or to soil anchors. For new construction, soil anchors inserted at the bottom of the excavation and attached to the tank can prevent the tank from buoying out of the ground in flooding, and this can be retrofitted to existing construction. As for pumping water into a tank to prevent buoyancy, it is extremely important to assure that the material will not react with water. Bracing of tanks to prevent horizontal movement caused by flood waters can also confer the benefit of added earthquake and wind resistance.

How to proceed, sources of information: See **flood countermeasure 1: flood protection engineering;** OSHA General Industry Standards 1910.106 (b) (5) vii.

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Flood Countermeasure 6: Flood insurance

Losses to individuals or companies from flooding can be offset by the National Flood Insurance Program. Reduced insurance rates are given for floodproofing facilities. To qualify for these lower actuarial rates, the structure must be floodproofed to a level at or above the base flood elevation. The degree of floodproofing must be certified by a Professional Engineer or Registered Architect. Below the base flood elevation, the structure must be watertight with walls substantially impermeable to the passage of water. Structural components must have the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

Each structure at a facility is insured separately. The structure must be walled and roofed and located principally above ground. Contents must be within a totally enclosed building. Not covered by the flood insurance policy are: gas and liquid storage tanks, roads, motor vehicles, growing crops, land, bridges, or shrubbery. Flood insurance can only be purchased within local political jurisdictions that have met Federal requirements (such as restricting future development in flood-prone areas) and are enrolled in the flood insurance program.

The expenses incurred by the insured party while taking protective flood measures are included as part of the claim and are reimbursable under this policy. Also covered are those expenses of the removal, storage for up to 45 days, and return of the contents away from the possible flood site. Industrial employees' wages are also reimbursable at prevailing wage rates.

For a small business, the limit on the amount of insurance for each individual building on the site will be from $100,000 to $300,000. For a large business the coverage offered by NFIP is between $100,000 and $200,000 for each building on the site.

How to proceed, sources of information: All flood insurance is purchased through private insurance agents. The best place to start in obtaining information about flood insurance is the insurance agent who already handles your other insurance needs.

For more information about NFIP in California, contact California's State Coordinating Office:

State of California
Department of Water Resources
P.O. Box 388
Sacramento, CA 95802
(916) 445-2985

Information can also be obtained from the nearest Federal Emergency Management Agency office.

Flood Countermeasure 7: Evacuation

After a review of flood maps and if a facility is subject to significant flooding, the following evacuation planning steps should be taken.

1. Determine if the entire site might require evacuation, or whether only a portion of the site would be flooded, and other buildings could be remain in use.

2. Consider the circumstances under which utililty outages would require evacuation of the site (lack of heat, water, electricity, phones, etc.) even in the absence of severe onsite flooding.

3. Devise two different escape routes that would not be flooded.

4. Contact local authorities (emergency services office, police, fire) to see what plans the public agencies have for flood evacuations.

5. Find out how information on a developing flood situation would be obtained (see **flood countermeasure 4: obtaining accurate information on the progression of a flood during a storm.**

6. Develop a management plan for evacuation decisionmaking: Who is responsible?

7. Decide how to communicate an evacuation instruction to employees or building occupants. Consider both the people onsite and those who may be elsewhere (such as off-shift employees who must be told not to report to work).

8. If an alternative facility could be used, such as another branch of the same business, determine if all employees should report to the same place, or if different instructions should be issued.

9. Designate employees who, as long as it is safe, will stay on-site to aid in the evacuation and shutdown; these peopie should know these roles ahead of time.

10. Issue ID cards to employees to aid in their passage through police lines to return to the site after a flood evacuation.

Flood Countermeasure 8: Move valuable records and movable equipment to elevations above flood levels or to another site.

Placing items up off the ground onto shelves and tables may provide enough clearance to prevent damage from minor flooding. In multi-story buildings, items can be moved to an upper level. Relocation to another facility may be required if the expected flood water elevation will be more than two or three feet above the facility's floor level.

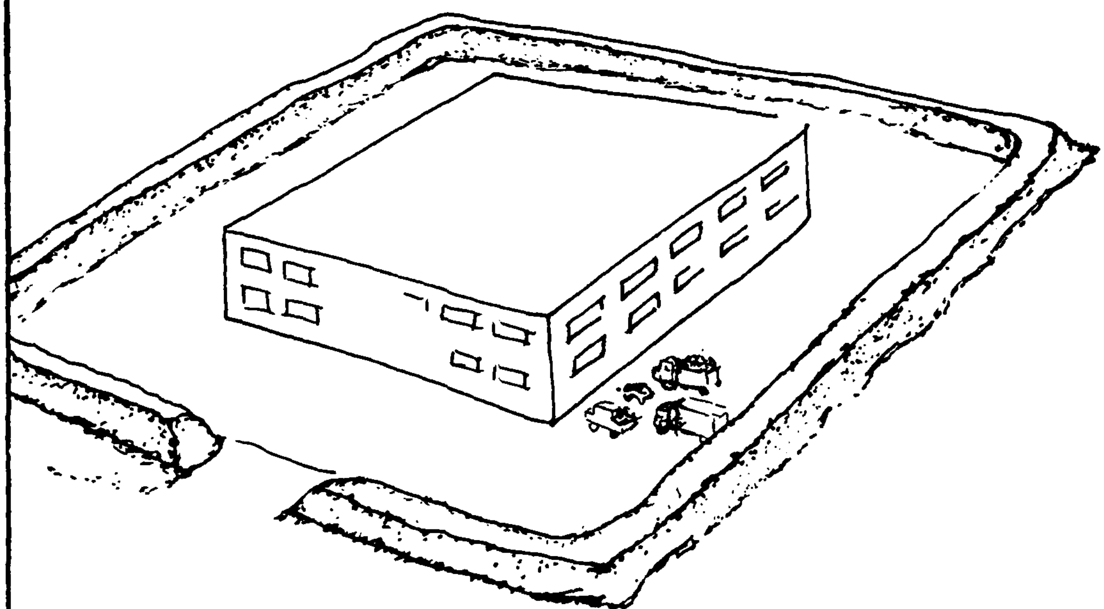
In new construction, key pieces of equipment, such as emergency generators, can be located above an expected flood water elevation by the use of steel support legs, bolting to wall supports, or placement in upper stories or on roofs.

Quick disconnect electrical plugs can be installed to permit rapid removal and re-installation of larger machinery.

Approximate cost: For quick disconnect plugs on machinery, about $100 each.

Flood Countermeasure 9: Protect new or existing construction by surrounding berm.

In some cases, local design standards lead to the use of landscaped berms (mounds of earth) to screen the view of parking areas from the street or adjacent properties, and the addition of extra berms on other sides of the site may be all that is required to provide a complete protective barrier against flood waters. Driveway entrances could be quickly protected with sandbags or piles of soil protected with plastic sheeting in the event that a flood is imminent. Pumping may be required to prevent the accumulation of water within the protectively bermed area. Blocking off storm drains may be required to prevent water from forcing its way up and out of drain pipes into the bermed area.



Approximate cost: \$10-20 per lineal foot of berm 3 feet high; \$20-40 per lineal foot of berm 6 feet high. Another cost is the area of land taken up by the berm, which is approximately 10 square feet for each lineal foot of 3 foot high berm, and 20 square feet for each lineal foot of 6 foot high berm.

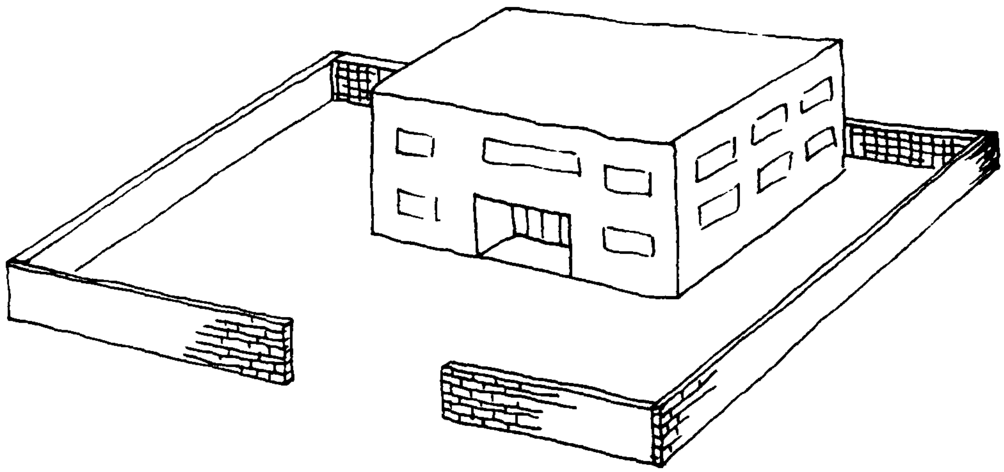
How to proceed, sources of information: see **flood countermeasure 1: flood protection engineering.**

In new construction, typically the architect is the lead designer who would have to incorporate a berm into the initial design of a facility; a landscape architect or civil engineer serving as consultant to the architect might carry out the detailed design of the berm and its landscaping and drainage aspects.

Flood Countermeasure 10: Flood protection fence

As an alternative to a berm to protect a facility from flood water, a solid fence (freestanding wall) may be used to serve the same purpose. Reinforced concrete block or brick, or pre-cast reinforced concrete are the most likely alternatives because they are economically used for general fencing purposes and can be strong enough to resist water pressure. In general, a reinforced wall designed to resist earthquakes or high winds can also be made to act as a dam resisting water up to about half its height with no extra cost. For small extra cost, a wall can be designed to resist flood water pressures to greater heights. "Reinforced" means that the wall has been properly strengthened with steel reinforcing bars; unreinforced masonry walls are much weaker than reinforced ones.

Solid fences of masonry or concrete can also provide some sound control, security, fire protection, and visual screening advantages, which are the usual reasons for their construction.



Approximate cost: \$6 per square foot of wall area. Only about 1/2 square foot of land area is taken up for each 1 lineal foot of wall, which is a great cost advantage over berms wherever real estate is expensive.

How to proceed, sources of information: See **flood countermeasure 1: flood protection engineering.**
For new construction, typically the architect is the lead designer who would have to incorporate a solid fence into the initial design of a facility; the detailed structural design might then be done by the structural engineering consultant working for the architect.

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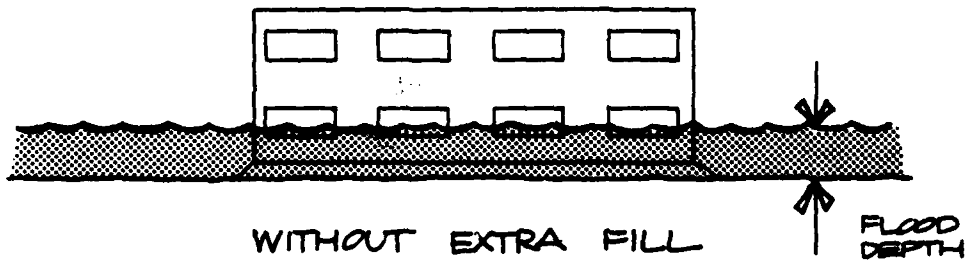
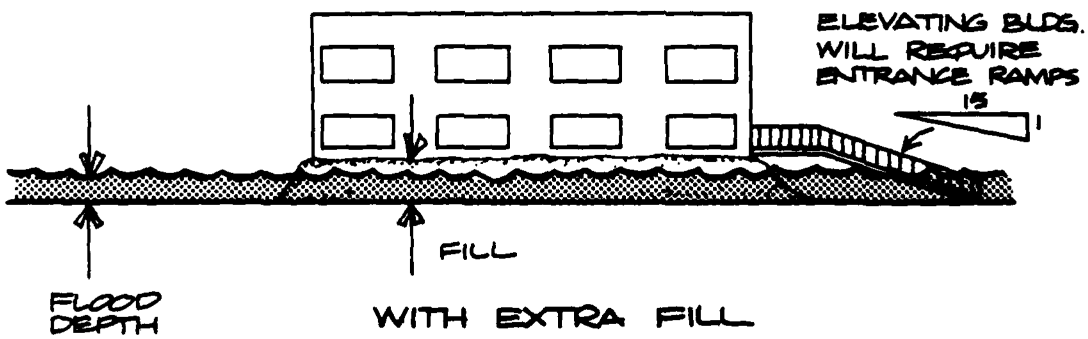
Flood Countermeasure 11: Elevate new construction above expected flood level with added earthfill.

This countermeasure is suitable for slab-on-grade construction (in which the concrete ground floor is poured on the ground, or more precisely, on layers or gravel, sand, plastic vapor barriers, or compacted earth, which in turn rest upon the natural ground). The expected flood level can be only a few feet above the natural grade for this type of flood protection scheme to be feasible.

Earthfill must be designed and field inspected by a civil engineer to ensure proper compaction by earth moving equipment, in which case this extra layer of soil can perform as well as or in some cases better than the natural soil. If improper soil materials are used or carelessly placed and compacted, then damage to the building can result over the following years as the fill settles.





Approximate cost: 50 cents-$1 per cubic foot of fill; (a square foot of ground floor area with 1 foot of extra fill required would be 1 cubic foot).

How to proceed, sources of information: See **flood countermeasure 1: flood protection engineering**. The architect who designs the building can be directed to consider whether this option is feasible and how it would affect the overall design. The architect's in-house or consulting engineer would then engineer the details of the fill and foundation.

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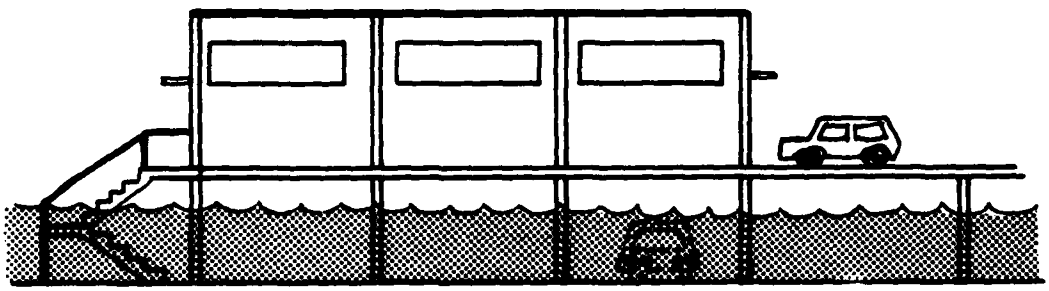
Flood Countermeasure 12: Elevate new construction above expected flood level with "stilts."

This approach is suitable only for two-or-more story buildings that do not require a ground level floor (though if parking and an entrance is provided at the elevated entry level, this limitation can be minimized).

The "stilts" must be designed to provide proper structural support. To avoid the notorious earthquake weakness of a "soft ground story," in which a rigidly walled box structure is supported by flexible ground story columns that are weaker, rather than stronger, than the upper stories, either some solid walls are required at ground level or else the entire structure should be uniformly stiffened by a column-beam rigid frame with the upper levels infilled with nonstructural walls.



Approximate cost: Varies too much to estimate; little or no extra cost is involved if the design that is desired for the facility for non-flood reasons can easily accommodate the placement of parking under the structure; otherwise, the cost is high.

How to proceed, sources of information: The architect who will design the overall building can be directed to consider whether this option is feasible. If so, detailed structural aspects of the design would probably be handled by the architect's engineer.

Countermeasure Summary

List the names of the countermeasures that appear to merit further attention in approximate order of priority. For each countermeasure, add notes where possible indicating approximate cost, whether this type of countermeasure is already adequately implemented, and whether pursuit of this countermeasure would be handled internally or would require outside assistance.

COUNTER-MEASURE	COST	ALREADY DONE?	INTERNAL	EXTERNAL

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POWER OUTAGE COUNTERMEASURES

Power Outage Countermeasure

Procedure:

1. Use the checklist and flowchart to identify your **critical** alternative energy demands at your plant.

2. Develop a matrix of these critical applications versus: their individual power demands, and what each cost would be in a sudden shutdown if you had no alternative.

3. Add up the total power demand that must be met at peak load. (Don't forget to consider the possibility of cycling individual loads on and off during an emergency as a means to reduce peak load demand.)

4. For any mechanical equipment that must be started while other demand loads must be met (e.g., cycling of large motors), be sure to list the "locked rotor start up current" (which is generally much greater than the continuous duty current demand).

5. Total the worst case demand, considering all combinations of shutdown, start up and cycling.

6. Select a system from the power outage factsheet that would meet the worst case demand to obtain a rough estimate of the cost.

7. Total the loss column in your matrix and establish what your tradeoff benefit would be. If the system cost is less than or equal to your potential loss costs, then you should investigate further.

Additional Considerations

Also estimate the cost of exercising the unit regularly. Some hospitals run their standby units for an hour once a week; industrial plants generally use monthly intervals. (So you may wish to consider use of your standby system in a **noncritical** portion of the production facility so it will receive regular exercise but be available to switch over to a **critical** operation in an emergency.)

Your analysis outcome at item 7 may show one single power outage would cost more than a standby unit. However, to realize that benefit, a power outage must occur. The probability of a power outage occurring at a given location is difficult to assess, and may never happen. But, there is an alternative strategy that can reduce the cost of standby insurance significantly.

The standby system will do better when scheduled on a duty cycle that is intermitant, so that it will receive the regular exercise required to ensure it will operate reliably when needed. Coupled with some of the benefits offered by utilities (see the Power Outage factsheet; PG&E) it is possible to have the benefit of onsite standby generator insurance **at a profit.**

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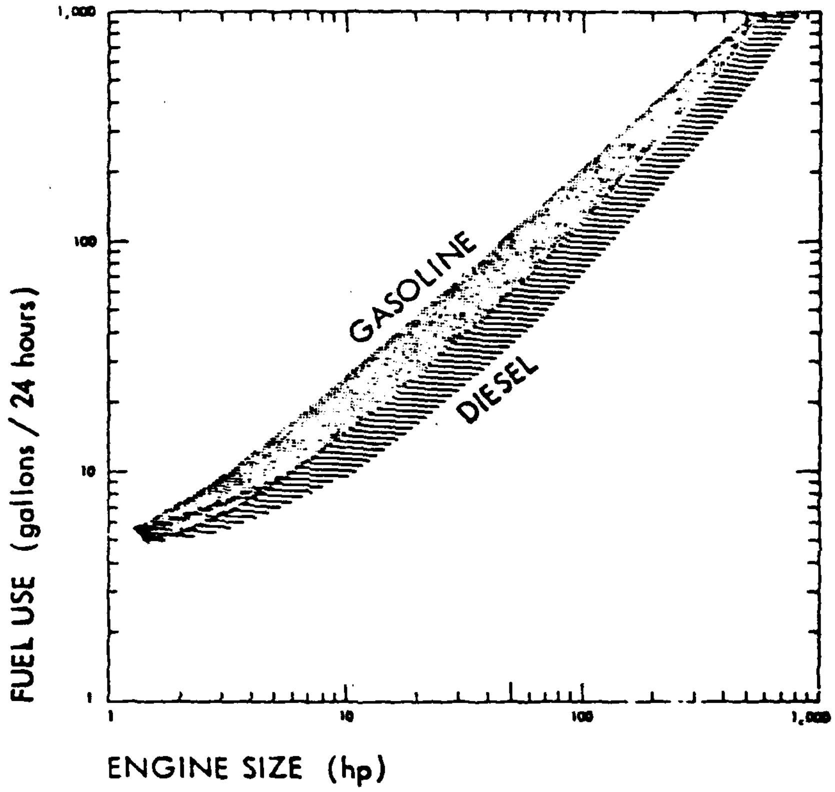
FUEL CELLS		15 TO 5,000			544 AT 5,000 TO 26,000					
HYDRO	RELIABLE, EVERYDAY [3]	200 TO 15,000	HEAVY, LOCAL; STREAM SITE	NEED RIVER & RIGHTS	1,000 TO 2,000 AT 5,000	•	~ 2 YRS RUN OF THE RIVER 6-7 YRS OTHERWISE	WATER FLOW	LIGHT TO NIL	VERY LOW
WIND	SPORADIC, [4] EVERYDAY	100 TO 2,000	MODERATE, REGIONAL	MINIMUM WIND 8-10 MPH MAXIMUM WIND 20-30 MPH STORAGE LIMITED	1,000 TO 3,000 AT 2 TO 10	•	> 3 YEARS	AIR FLOW	NONE	LOW
GEOTHERMAL	RELIABLE, EVERYDAY	10,000 TO 100,000	SEVERE REGIONAL	NEED WATER AND MINERAL RIGHTS	UNKNOWN	UNKNOWN	> 5 YEARS	GEOTHERMAL	NIL	VERY LOW
STANDBY ENGINE GENERATOR	PERIODIC NONSTEADY EMERGENCIES	5 TO 10,000	NONE	ENVIRONMENTAL ISSUES	PER SET (1980) GASOLINE: 0-5 KW $491; 5.1-15 KW $1,574; 15.1-35 KW $2,950; 35.1-100 KW $7,587; 100.1 → $44,578 DIESEL: 14 KW $3,493; 14.1-50 KW $7,350; 50.1-100 KW $12,896; 100.1-200 KW $16,603; 200.1-400 KW $28,987; 400.1-1000 KW $62,716; 1000.1 → $330,467	INVESTMENT TAX PLUS LOCAL UTILITY	1-7 DAYS RENTAL 2-10 WK. PURCHASE	LIQUID GAS	SEVERE HEAVY	HARDEN
CONVERTED INDUCTION MOTOR	EMERGENCY ONLY	1 TO 300	NONE	NEED CONVERSION KIT, PRIME MOVER SPARE MOTOR	UNKNOWN	NONE	1-2 DAYS WITH CONVERSION KIT	DEPENDS ON PRIME MOVER	HEAVY TO SEVERE	HARDEN

[1] FOR UNITS OVER A CERTAIN SIZE, CALIFORNIA UTILITY PROGRAMS OFFER GUARANTEED POWER COST PLUS $10,000 ANNUALLY TO STAY "OFF-LINE" DURING PEAK DEMAND SEASON

[2] MINIMUM TIME FOR SMALL UNITS AND WASTE HEAT UNITS, LONGER TIMES ARE FOR LARGE SYSTEMS

[3] SUBJECT TO SEASONAL INTERRUPTION ON SOME STREAMS

[4] SUBJECT TO DAILY INTERRUPTION



Engine Generator Fuel Consumption.

POWER OUTAGE

Countermeasure Summary

List the names of the countermeasures that appear to merit further attention in approximate order of priority. For each countermeasure, add notes where possible indicating approximate cost, whether this type of countermeasure is already adequately implemented, and whether pursuit of this countermeasure would be handled internally or would require outside assistance.

COUNTER-MEASURE	COST	ALREADY DONE?	INTERNAL	EXTERNAL

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APPENDIX B

SAMPLE DATA BASE FROM A DESIGN STUDY FOR A CHEMICAL PLANT

IDENTIFICATION:	**ITEM:** Flaker **ITEM NO.:** H 11 **NO. REQUIRED:** 1	**Date:** April 1, 1979 **By:** G.M.S. Jr.

FUNCTION: To solidify and flake 99.7% Phthalic Anhydride

OPERATION: 24 hrs per day, 315 days per year

DESIGN DATA:

Material handled: 1670 lb per hour 99.7% Phthalic Anhydride
Inlet temperature: 150 C
Solidification temperature: 131 C
Latent heat: 68 Btu/lb
Specific heat: 0.72 Btu/lb C
Heat Load: 136,000 Btu/hr
Overall coefficient: 33 Btu/hr ft^2 C

Required heat transfer area: 25 ft^2
Driver: 2 Hp fully enclosed, constant speed electric motor

UTILITIES: Electricity, water

CONTROLS:

INSULATION:

TOLERANCES:

COMMENTS AND DRAWINGS:

COST:

Flaker :	\$28,750.00
Motor:	300.00
	\$29,050.00

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Heat Exchanger **ITEM NO.:** H8 **NO. REQUIRED:** 1
SERVICE: Dehydrate crude Phthalic Anhydride and remove inpurities	
TYPE RECOMMENDED:	Cylindrical vessel
DUTY, BTU/HR:	42,280
HEAT TRANSFER COEFFICIENT:	30 Btu/hr ft^2 F
HEAT TRANSFER AREA, SQ FT:	
TUBE SIDE:	
FLUID HANDLED:	
FLOWRATE, LB/HR:	15,000 Watts
TEMPERATURES,F:	
PRESSURE, PSIA:	
NUMBER OF TUBES:	
LENGTH, FT	
DIAMETER, IN.:	
GAUGE:	
FLUID VELOCITY, FPS:	
PASSES:	
TUBE MATERIAL:	
HEAD MATERIAL:	
SHELL SIDE:	
FLUID HANDLED:	Crude Phthalic Anhydride
FLOWRATE, LB/HR:	7,000
TEMPERATURES, F:	535
PRESSURE, PSIA:	14.7
PASSES:	15.0
DIAMETER, IN.:	9.0
THICKNESS, IN.:	0.25
INSULATION:	1 inch Cal Sil
PRICE:	$43,225.00

ADDITIONAL: Vessel is surmounted with a packed column 4 ft in height, with internal diameter of 6 in., constructed of ¼ in. 304 stainless steel plate with a flat top.

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:

ITEM: Reboiler
ITEM NO.: H9
NO. REQUIRED: 1

SERVICE: Vaporize Phthalic Anhydride for feed to distillation column

TYPE RECOMMENDED:	Calandria
DUTY, BTU/HR:	3.165×10^6
HEAT TRANSFER COEFFICIENT:	80 Btu/hr ft^2 F
HEAT TRANSFER AREA, SQ FT:	1,236

TUBE SIDE:

FLUID HANDLED:	Steam	
FLOWRATE, LB/HR:	3,800	
TEMPERATURES,F:	inlet-392	outlet-392
PRESSURE, PSIA:	225	
NUMBER OF TUBES:	1,580	
LENGTH, FT	4	
DIAMETER, IN.:	0.75	
GAUGE:	13 BWG	
FLUID VELOCITY, FPS:		
PASSES:	1	
TUBE MATERIAL:	304 stainless steel	
HEAD MATERIAL:	304 stainless steel	

SHELL SIDE:

FLUID HANDLED:	99% Phthalic Anhydride
FLOWRATE, LB/HR:	6,500
TEMPERATURES, F:	360
PRESSURE, PSIA:	1.0
PASSES:	18.3
DIAMETER, IN.:	8.5
THICKNESS, IN.:	5/8
INSULATION:	1 inch Cal Sil
PRICE:	$290,500.00
ADDITIONAL:	

EQUIPMENT SPECIFICATIONS		
IDENTIFICATION:	**ITEM:** Heater **ITEM NO.:** H6 **NO. REQUIRED:** 1	
FUNCTIONS: To cool hot Dowtherm A from switch condenser		
OPERATION: Continuous		
TYPE: Horizontal, Floating Head **DUTY, BTU/HR:** 382,600 **HEAT TRANSFER COEFFICIENT:** 28.3 Btu/ft hr F **HEAT TRANSFER AREA, SQ FT:** 150		
TUBE SIDE:		
FLUID HANDLED: **FLOW RATE:** **TEMPERATURE:** **PRESSURE:** **HEAD MATERIAL:**	Untreated cool water 12 gpm 65 to 140 F 14.7 psia Carbon steel	**TUBE:** 3/4 in. diameter -- 18 **BWG** 0.25 in. **CENTERS** ☐ **PATTERN** 104 **TUBES EACH** 8 **FT LONG** 1 **PASS** **TUBE MATERIAL:** Carbon steel
SHELL SIDE:		
FLUID HANDLED: **FLOW RATE:** **TEMPERATURE:** **PRESSURE:** **THICKNESS:**	Dowtherm A 77.2 lb/hr 212 to 122 F 14.7 psia 0.22 in.	**Shell:** 13.7 in. diameter -- 1 **PASS** **PASSES** (tranverse baffles - 12, longtudinal baffles - 0) **SHELL MATERIAL:** Carbon steel
UTILITIES:	Untreated cool water	
INSULATION:	1 inch magnesia	
TOLERANCES:	Tubular Exchangers Manufacturers Association (TEMA) standards	
PRICE:	$4,841	
ADDITIONAL:		

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Cooler **ITEM NO.:** H3 **NO. REQUIRED:** 1	
SERVICE: Cool Dowtherm from primary condenser		
TYPE RECOMMENDED:	Floating head	
DUTY, BTU/HR:	4.6×10^6	
HEAT TRANSFER COEFFICIENT:	125 Btu/hr ft^2 F	
HEAT TRANSFER AREA, SQ FT:	230	
TUBE SIDE:		
FLUID HANDLED:	Water	
FLOWRATE, LB/HR:	61,300	
TEMPERATURES,F:	inlet-65	outlet-140
PRESSURE, PSIA:	atm	
NUMBER OF TUBES:	75	
LENGTH, FT	16	
DIAMETER, IN.:	3/4	
GAUGE:	14 BWG	
FLUID VELOCITY, FPS:	2	
PASSES:	1	
TUBE MATERIAL:	Admiralty brass	
HEAD MATERIAL:	Carbon steel	
SHELL SIDE:		
FLUID HANDLED:	Dowtherm A	
FLOWRATE, LB/HR:	33,250	
TEMPERATURES, F:	inlet-412	outlet-149
PRESSURE, PSIA:	1	
PASSES:	12	
DIAMETER, IN.:	3/8	
THICKNESS, IN.:		
INSULATION:		
PRICE:	$8,440.00	
ADDITIONAL:		

EQUIPMENT SPECIFICATIONS		
IDENTIFICATION:	**ITEM:** Condenser **ITEM NO.:** H10 **NO. REQUIRED:** 1	
SERVICE: Total condenser for Phthalic Anhydride rectification tower		
TYPE RECOMMENDED:	Fixed tube sheet	
DUTY, BTU/HR:	3.51×10^6	
HEAT TRANSFER COEFFICIENT:	30 Btu/hr ft^2 F	
HEAT TRANSFER AREA, SQ FT:	1960	
TUBE SIDE:		
FLUID HANDLED:	Dowtherm A	
FLOWRATE, LB/HR:	148,290	
TEMPERATURES,F:	inlet-275	outlet-320
PRESSURE, PSIA:	atm	
NUMBER OF TUBES:	624	
LENGTH, FT	16	
DIAMETER, IN.:	0.75	
GAUGE:	16	
FLUID VELOCITY, FPS:	4.1	
PASSES:	8	
TUBE MATERIAL:	304 stainless steel	
HEAD MATERIAL:	304 stainless steel	
SHELL SIDE:		
FLUID HANDLED:	Phthalic Anhydride vapor--condensing	
FLOWRATE, LB/HR:	18,000 max	
TEMPERATURES, F:	inlet-360	outlet-360
PRESSURE, PSIA:	1.0	
PASSES:	1	
DIAMETER, IN.:	30	
THICKNESS, IN.:	3/8	
INSULATION:		
PRICE:	$89,500.00	
ADDITIONAL:		

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:
ITEM: Switch Condenser
ITEM NO.: H4
NO. REQUIRED: 8

FUNCTION: To condense Phthalic Anhydride vapors not condensed by primary condenser.

OPERATION: 3.5 hour cycle -- 2.5 hours condensing, 0.5 hours melt-out, 0.5 hours cooling

TYPE: See attached dwg
DUTY, BTU/HR: 422,000 melt-out, 382,600 condensing
HEAT TRANSFER COEFF.: 9.7 Btu/hr ft^2 F
HEAT TRANSFER AREA: 3,350 sq ft

TUBE SIDE:
FLUID HANDLED: Dowtherm A
FLOW RATE: 7,712 lb/hr condensing; 18,348 lb/hr melt-out
TEMPERATURE: Outlet: 122 F condensing; 330 F melt-out
Inlet: 212 F condensing; 280 F melt-out

TUBE DIAMETER: IN.: 1.0 **GAUGE:** 12 BWG **LENGTH FT:** 8
NO. TUBES: 550 **NO. PASS:** 1
TUBE MATERIAL: 304 stainless steel

ADDITIONAL: Tube to have 6 longitudinal fins, ½" high, 0.109" thick

SHELL SIDE:
FLUID HANDLED: Phthalic Anhydride vapor and waste gases on condensing, solid Phthalic Anhydride on melt-out
FLOW RATE: 145,562 cubic ft/hr condensing, 504 lb/hr melt-out
PRESSURE:
TEMPERATURE: Outlet: 268 F condensing; 300 F melt-out
Inlet: 392 F condensing; 268 F melt-out

LENGTH: 15.5 ft **HEIGHT:** 8.5 ft **WIDTH:** 9.5 ft
THICKNESS: 0.355 in. **MATERIAL:** 304 stainless steel

INSULATION: 1½ inch rock, cork, or equivalent

TOLERANCES: TEMA standards

PRICE: $135,254.00

ADDITIONAL:

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION:	**ITEM:** Primary Condenser **ITEM NO.:** H2 **NO. REQUIRED:** 1
SERVICE: Condense 60% Phthalic Anhydride from reactor	
TYPE RECOMMENDED:	Floating head
DUTY, BTU/HR:	4.6×10^6
HEAT TRANSFER COEFFICIENT:	30 Btu/hr ft^2 F
HEAT TRANSFER AREA, SQ FT:	810
TUBE SIDE:	
FLUID HANDLED:	Dowtherm A
FLOWRATE, LB/HR:	33,250
TEMPERATURES,F:	inlet-149 outlet-412
PRESSURE, PSIA:	atm
NUMBER OF TUBES:	310
LENGTH, FT:	16
DIAMETER, IN.:	5/8
GAUGE:	14 BWG
FLUID VELOCITY, FPS:	0.42
PASSES:	1
TUBE MATERIAL:	304 stainless steel
HEAD MATERIAL:	304 stainless steel
SHELL SIDE:	
FLUID HANDLED:	Reactor product gases
FLOWRATE, LB/HR:	41,400
TEMPERATURES, F:	inlet-662 outlet-289
PRESSURE, PSIA:	23.7
PASSES:	1
DIAMETER, IN.:	36
THICKNESS, IN.:	3/8
INSULATION:	1 inch Cal Sil
PRICE:	$54,175.00
ADDITIONAL:	

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Heater **ITEM NO.:** H7 **NO. REQUIRED:** 1	
SERVICE: To heat crude product storage tank		
TYPE RECOMMENDED:		
DUTY, BTU/HR:	205900	
HEAT TRANSFER COEFFICIENT:	20 Btu/hr ft^2 F	
HEAT TRANSFER AREA, SQ FT:	312	
TUBE SIDE: See attached drawing for specific design requirements		
FLUID HANDLED:	Steam	
FLOWRATE, LB/HR:	238	
TEMPERATURES,F:	inlet-358	outlet-358
PRESSURE, PSIA:	130 psia	
NUMBER OF TUBES:		
LENGTH, FT		
DIAMETER, IN.:	2.0 nominal	
GAUGE:	13 BWG	
FLUID VELOCITY, FPS:	11.2	
PASSES:		
TUBE MATERIAL:	304 stainless steel	
HEAD MATERIAL:		
SHELL SIDE:		
FLUID HANDLED:	96.0% Phthalic Anhydride	
FLOWRATE, LB/HR:		
TEMPERATURES, F:	320	
PRESSURE, PSIA:	14.7	
PASSES:		
DIAMETER, IN.:		
THICKNESS, IN.:		
INSULATION:		
PRICE:	$4,650.00	
ADDITIONAL: See attached drawing for specific design requirements		

EQUIPMENT SPECIFICATIONS
IDENTIFICATION: **ITEM:** Heater **ITEM NO.:** H5 **NO. REQUIRED:** 1
FUNCTIONS: To heat up Dowtherm A for melting Phthalic Anhydride in switch condenser
OPERATION: Continuous
TYPE: Horizontal, Floating Head **DUTY, BTU/HR:** 422,000 **HEAT TRANSFER COEFFICIENT:** 14 Btu/ft hr F **HEAT TRANSFER AREA, SQ FT:** 263
TUBE SIDE: **FLUID HANDLED:** Saturated steam **FLOW RATE:** 353lb/hr **TEMPERATURE:** 366 to 366 F **PRESSURE:** 150 psig **HEAD MATERIAL:** Carbon steel **TUBE:** 1 in. diameter -- 14 **BWG** 0.25 in. **CENTERS -- □ PATTERN** 136 **TUBES EACH 8 FT LONG** **2 PASSES** **TUBE MATERIAL:** Carbon steel
SHELL SIDE: **FLUID HANDLED:** Dowtherm A **FLOW RATE:** 18 348 lb/hr **TEMPERATURE:** 280 to 330 F **PRESSURE:** 14.7 psia **THICKNESS:** 0.22 in. **Shell:** 19.7 in. diameter -- 1 **PASS** (tranverse baffles - 10, longitudinal baffles - 0) **SHELL MATERIAL:** Carbon steel
UTILITIES: Saturated steam at 150 psig
INSULATION: 1 inch magnesia
TOLERANCES: Tubular Exchangers Manufacturers Association (TEMA) standards
PRICE: $7,593
ADDITIONAL:

EQUIPMENT SPECIFICATIONS		
IDENTIFICATION:	**ITEM:** Heater **ITEM NO.:** H1 **NO. REQUIRED:** 1	
SERVICE: Pre-heat fluidization and process air to reactor		
TYPE RECOMMENDED: **DUTY, BTU/HR:** **HEAT TRANSFER COEFFICIENT:** **HEAT TRANSFER AREA, SQ FT:**	Direct-fired 1.5×10^6	
TUBE SIDE:		
FLUID HANDLED:		
FLOWRATE, LB/HR:		
TEMPERATURES,F:	inlet-	outlet-
PRESSURE, PSIA:		
NUMBER OF TUBES:		
LENGTH, FT		
DIAMETER, IN.:		
GAUGE:		
FLUID VELOCITY, FPS:		
PASSES:		
TUBE MATERIAL:		
HEAD MATERIAL:		
SHELL SIDE:		
FLUID HANDLED:	$Air/0_2$ mixture	
FLOWRATE, LB/HR:	4343 cfm	
TEMPERATURES, F:	inlet-280	outlet-572
PRESSURE, PSIA:	44.1	
PASSES:		
DIAMETER, IN.:		
THICKNESS, IN.:		
INSULATION:		
PRICE:	$19,809.00	
ADDITIONAL:		

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION: **ITEM:** Pump **ITEM NO:** P3 **NO. REQUIRED:** 1	
SERVICE: Napthalene/O-Xylene feed pump to reactor	
FLUID HANDLED: **CORROSIVE OR NON-CORROSIVE:** **FLOW RATE, GPM OR CFM:**	Napthalene & O-Xylene Non-corrosive 14 gpm
SUCTION PRESSURE, PSIA: **DISCHARGE PRESSURE, PSIA:** **DIFFERENTIAL PRESSURE, PSIA:**	14.7 44.1 29.4
TYPE RECOMMENDED: **EFFICIENCY, %:** **MATERIALS OF CONSTRUCTION:**	Centrifugal 80 Carbon steel
PRICE:	$150.00

IDENTIFICATION: **ITEM:** Pump **ITEM NO:** P4 **NO. REQUIRED:** 1	
SERVICE: Primary condenser Dowtherm circulation pump	
FLUID HANDLED: **CORROSIVE OR NON-CORROSIVE:** **FLOW RATE, GPM OR CFM:**	Dowtherm A Non-corrosive 70 gpm
SUCTION PRESSURE, PSIA: **DISCHARGE PRESSURE, PSIA:** **DIFFERENTIAL PRESSURE, PSIA:**	14.7 29.4 14.7
TYPE RECOMMENDED: **EFFICIENCY, %:** **MATERIALS OF CONSTRUCTION:**	Centrifugal=close coupled 60 Carbon steel
PRICE:	$123.00

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION: ITEM: Pump ITEM NO: P5 NO. REQUIRED: 1	
SERVICE: Primary condenser surge tank pump	
FLUID HANDLED:	96% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	60 gpm
SUCTION PRESSURE, PSIA:	14.7
DISCHARGE PRESSURE, PSIA:	22.8
DIFFERENTIAL PRESSURE, PSIA:	8.1
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	80
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$2,670.00

IDENTIFICATION: ITEM: Pump ITEM NO: P6 NO. REQUIRED: 1	
SERVICE: Dowtherm A cooler feed	
FLUID HANDLED:	Dowtherm A
CORROSIVE OR NON-CORROSIVE:	Non-corrosive
FLOW RATE, GPM OR CFM:	30 gpm
SUCTION PRESSURE, PSIA:	8.8
DISCHARGE PRESSURE, PSIA:	2.1
DIFFERENTIAL PRESSURE, PSIA:	10.9
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	60%
MATERIALS OF CONSTRUCTION:	Carbon steel
PRICE:	$1,868.00

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION: ITEM: Pump ITEM NO: P7 NO. REQUIRED: 1	
SERVICE: Dowtherm A heater feed	
FLUID HANDLED:	Dowtherm A
CORROSIVE OR NON-CORROSIVE:	Non-corrosive
FLOW RATE, GPM OR CFM:	80 gpm
SUCTION PRESSURE, PSIA:	8.3
DISCHARGE PRESSURE, PSIA:	2.3
DIFFERENTIAL PRESSURE, PSIA:	10.6
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	60%
MATERIALS OF CONSTRUCTION:	Carbon steel
PRICE:	$3,113.00

IDENTIFICATION: ITEM: Pump ITEM NO: P8 NO. REQUIRED: 1	
SERVICE: Phthalic Anhydride surge tank feed	
FLUID HANDLED:	Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Slightly corrosive
FLOW RATE, GPM OR CFM:	12 gpm
SUCTION PRESSURE, PSIA:	5.2
DISCHARGE PRESSURE, PSIA:	19.3
DIFFERENTIAL PRESSURE, PSIA:	24.5
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	70%
MATERIALS OF CONSTRUCTION:	Stainless steel
PRICE:	$1,832.00

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Pump **ITEM NO:** P9 **NO. REQUIRED:** 1
SERVICE: Crude product from storage to pre-treater	
FLUID HANDLED:	96% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	445 gpm
SUCTION PRESSURE, PSIA:	14.5
DISCHARGE PRESSURE, PSIA:	22.3
DIFFERENTIAL PRESSURE, PSIA:	7.8
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	80%
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$3,180.00

IDENTIFICATION:	**ITEM:** Pump **ITEM NO:** P10 **NO. REQUIRED:** 1
SERVICE: Dehydrated Phthalic Anhydride from pre-treater to reboiler	
FLUID HANDLED:	99% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	430 gpm
SUCTION PRESSURE, PSIA:	14.6
DISCHARGE PRESSURE, PSIA:	14.7
DIFFERENTIAL PRESSURE, PSIA:	0.1
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	80%
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$1,712.00

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION:	**ITEM:** Pump **ITEM NO:** P11 **NO. REQUIRED:** 1
SERVICE: Distillation condenser surge tank pump	
FLUID HANDLED:	96.0% to 99.7% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	35 gpm
SUCTION PRESSURE, PSIA:	1.5
DISCHARGE PRESSURE, PSIA:	14.7
DIFFERENTIAL PRESSURE, PSIA:	13.2
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	80
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$2,470.00

IDENTIFICATION:	**ITEM:** Vacuum Pump **ITEM NO:** P12 **NO. REQUIRED:** 1
SERVICE: To maintain vacuum in rectification column	
FLUID HANDLED:	
CORROSIVE OR NON-CORROSIVE:	
FLOW RATE, GPM OR CFM:	160 cfm
SUCTION PRESSURE, PSIA:	5 microns Hg
DISCHARGE PRESSURE, PSIA:	atm
DIFFERENTIAL PRESSURE, PSIA:	
TYPE RECOMMENDED:	Mechanical
EFFICIENCY, %:	
MATERIALS OF CONSTRUCTION:	
PRICE:	$11,290.00

EQUIPMENT SPECIFICATIONS

IDENTIFICATION: **ITEM:** Pump
ITEM NO: P13
NO. REQUIRED: 1

SERVICE: Pure product from storage to tank car service

FLUID HANDLED:	99.7% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	200 gpm
SUCTION PRESSURE, PSIA:	14.5
DISCHARGE PRESSURE, PSIA:	27.1
DIFFERENTIAL PRESSURE, PSIA:	12.6
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	50% (incl. inlet & outlet)
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$2,860.00

Includes 3.5 hp driver -- overall efficiency 40%

IDENTIFICATION: **ITEM:** Pump
ITEM NO: P14
NO. REQUIRED: 1

SERVICE: Pure product from storage to flaker

FLUID HANDLED:	99.7% Phthalic Anhydride
CORROSIVE OR NON-CORROSIVE:	Corrosive
FLOW RATE, GPM OR CFM:	10 gpm
SUCTION PRESSURE, PSIA:	14.5
DISCHARGE PRESSURE, PSIA:	16.0
DIFFERENTIAL PRESSURE, PSIA:	1.5
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	50% (incl. inlet & outlet)
MATERIALS OF CONSTRUCTION:	304 Stainless steel
PRICE:	$1,635.00

Includes ½ hp driver -- overall efficiency 40%

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Pump **ITEM NO:** P1 **NO. REQUIRED:** 1
SERVICE: Cooling water for reactor	
FLUID HANDLED:	Water
CORROSIVE OR NON-CORROSIVE:	Slightly
FLOW RATE, GPM OR CFM:	96.4 gpm
SUCTION PRESSURE, PSIA:	14.6
DISCHARGE PRESSURE, PSIA:	397.1
DIFFERENTIAL PRESSURE, PSIA:	382.5
TYPE RECOMMENDED:	Multi-stage centrifugal
EFFICIENCY, %:	60
MATERIALS OF CONSTRUCTION:	Cast-iron
PRICE: 35 hp pump	$6,390.00

IDENTIFICATION:	**ITEM:** Pump **ITEM NO:** P2 **NO. REQUIRED:**
SERVICE: To pump out tank cars into reactor feed tanks	
FLUID HANDLED:	Napthalene/O-Xylene
CORROSIVE OR NON-CORROSIVE:	Non-corrosive
FLOW RATE, GPM OR CFM:	240 gpm
SUCTION PRESSURE, PSIA:	14.5
DISCHARGE PRESSURE, PSIA:	14.7
DIFFERENTIAL PRESSURE, PSIA:	0.2
TYPE RECOMMENDED:	Centrifugal
EFFICIENCY, %:	60
MATERIALS OF CONSTRUCTION:	Carbon steel
PRICE:	$750.00

IDENTIFICATION: **ITEM:** Storage Tank **DATE:**
ITEM NO.: S9
NO. REQUIRED: 1 **BY:**

FUNCTION: Finished product storage

OPERATION:

DESIGN DATA:

Capacity -- 7 days production 1.06×10^6 lb
Temperature: 320 F
Internal steam coil heater
Cone roof

Diameter: 30 ft
Height: 21 ft

Material: 304 stainless steel
Insulated 1 inch on sides, 1 inch on top

Nozzles: Inlets: one 2.0 in.
Outlets: one 4.0 inch, one 2.0 inch

UTILITIES: Steam @ 150 psia

CONTROLS: Temperature sensor and flow control valve

INSULATION: Cal Sil

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $128,900.00

IDENTIFICATION:	**ITEM:** Storage Tank **ITEM NO.:** S7 **NO. REQUIRED:** 1	**DATE:** April 30, 1979 **BY:** April 30, 1979

FUNCTION: Storage of crude Phthalic Anhydride

CAPACITY: 60,000 gallons

DESIGN DATA:

Three days storage capacity - 547,650 lb
Phthalic Anhydride to be held at 320 F

Diameter: 23 ft
Height: 19.3 ft

UTILITIES: Steam @ 150 psia

CONTROLS: Temperature sensor and steam flow control valve

INSULATION: 1 inch Calcium Silicate

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $91,155.00

IDENTIFICATION:	**ITEM:** Storage Tank **ITEM NO.:** S1 **NO. REQUIRED:**	**DATE:** **BY:**

FUNCTION: O-Xylene storage tank

OPERATION:

DESIGN DATA:

Capacity: 14 days feed requirement

Diameter: 32 ft
Height: 34 ft
Capacity: 27,350 cubic ft
To be installed sub-surface

UTILITIES:

CONTROLS:

INSULATION:

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $54,030.00

IDENTIFICATION:	**ITEM:** Storage Tank **ITEM NO.:** S2 **NO. REQUIRED:** 1	**DATE:** **BY:**

FUNCTION: Napthalene storage tank

OPERATION:

DESIGN DATA:

Capacity: 14 days feed requirements

Diameter: 36 ft
Height: 37 ft
Capacity: 37,600 cubic ft
to be installed sub-surface

Steam coil heated

UTILITIES:

CONTROLS:

INSULATION: 1 inch Cal Sil

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $80,266

EQUIPMENT SPECIFICATIONS

IDENTIFICATION:	**ITEM:** Tank **ITEM NO:** S4 **NO. REQUIRED:** 1
SERVICE: Dowtherm A storage tank for cooler	
FLUID HANDLED:	Dowtherm A
CORROSIVE OR NON-CORROSIVE:	Non-corrosive
VOLUME:	680 gallons
DIMENSION:	3 x 5.5 x 5.5 ft
TYPE RECOMMENDED:	Floating roof
MATERIALS OF CONSTRUCTION:	Carbon steel
INSULATION:	1 inch mineral wool
PRICE:	$1,600

IDENTIFICATION:	**ITEM:** Tank **ITEM NO:** S5 **NO. REQUIRED:** 1
SERVICE: Dowtherm A storage tank for heater	
FLUID HANDLED:	Dowtherm A
CORROSIVE OR NON-CORROSIVE:	Non-corrosive
VOLUME:	1,730 gallons
DIMENSION:	4.5 x 7 x 7 ft
TYPE RECOMMENDED:	Floating roof
MATERIALS OF CONSTRUCTION:	Carbon steel
INSULATION:	1 inch mineral wool
PRICE:	$6,300

IDENTIFICATION:	**ITEM:** Surge Tank **ITEM NO.:** S3 **NO. REQUIRED:** 1	**DATE:** **BY:**

FUNCTION: Surge tank for primary condenser

OPERATION:

DESIGN DATA:

30 minutes production capacity

Capacity: 35 ft^3
Diameter: 3.0 ft
Height: 5.0 ft

Two wraps steam tracing at bottom

UTILITIES: Steam

CONTROLS: Level sensor & switching, control valve

INSULATION: 1 inch Cal Sil

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $6,490.00

EQUIPMENT SPECIFICATIONS	
IDENTIFICATION: ITEM: Tank ITEM NO: S6 NO. REQUIRED: 1	
SERVICE: Phthalic Anhydride surge tank	
FLUID HANDLED: CORROSIVE OR NON-CORROSIVE: VOLUME: DIMENSION:	Phthalic Anhydride Slightly corrosive 13 gallons 1.2 x 1.2 x 1.2 ft
TYPE RECOMMENDED: MATERIALS OF CONSTRUCTION: INSULATION:	Floating roof Stainless steel 1 inch mineral wool
PRICE:	$1,600

IDENTIFICATION:	**ITEM:** Surge Tank **ITEM NO.:** S8 **NO. REQUIRED:** 1	**DATE:** **BY:**

FUNCTION: Collect condensed PA vapor from distillation condenser

OPERATION: 7.25 hours per 8 hour distillation cycle

DESIGN DATA:

Capacity: 10 minutes of condenser operating capacity, 300 gallons

Material: 304 stainless steel

Nozzles: Inlet: 3.0 in.

Outlet: 1.5 in.

UTILITIES:

CONTROLS:

INSULATION:

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $4,315.00

IDENTIFICATION:	**ITEM:** Generator **ITEM NO.:** W-4 **NO. REQUIRED:** 1	**DATE:** **BY:**

FUNCTION: Electrical generator for process electricity

OPERATION: Continuous

DESIGN DATA:

Inlet pressure: 350 psia
Outlet pressure: 150 psia
Electrical output: 500 kW
Steam flow rate: Up to 40,000 lbs per hour

UTILITIES:

CONTROLS:

INSULATION:

TOLERANCES:

COMMENTS AND DRAWINGS:

COST: $100,000.00

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INDUSTRIAL HARDENING: 1982 TECHNICAL STATUS REPORT

Unclassified
Scientific Service, Inc., Redwood City, CA — May 1983
Contract EMW-C-0701, Work Unit 1124D — 191 pages

This report presents the results of the second year of a five-year program to improve and augment a self-help program in disaster preparedness for industry. Under the program, industrial protection guidelines have been developed to enable U.S. industry to reduce its vulnerability.

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